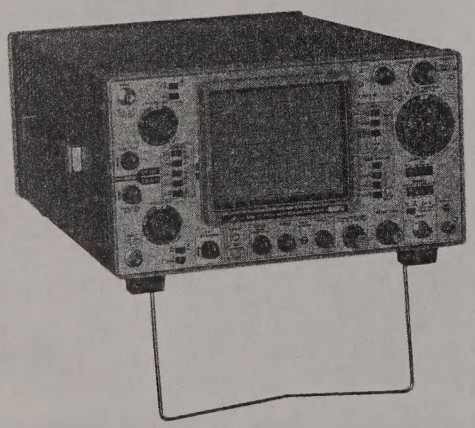
OPERATING MANUAL



OSCILLOSCOPE
SS-5705

F6281-7161052(I)

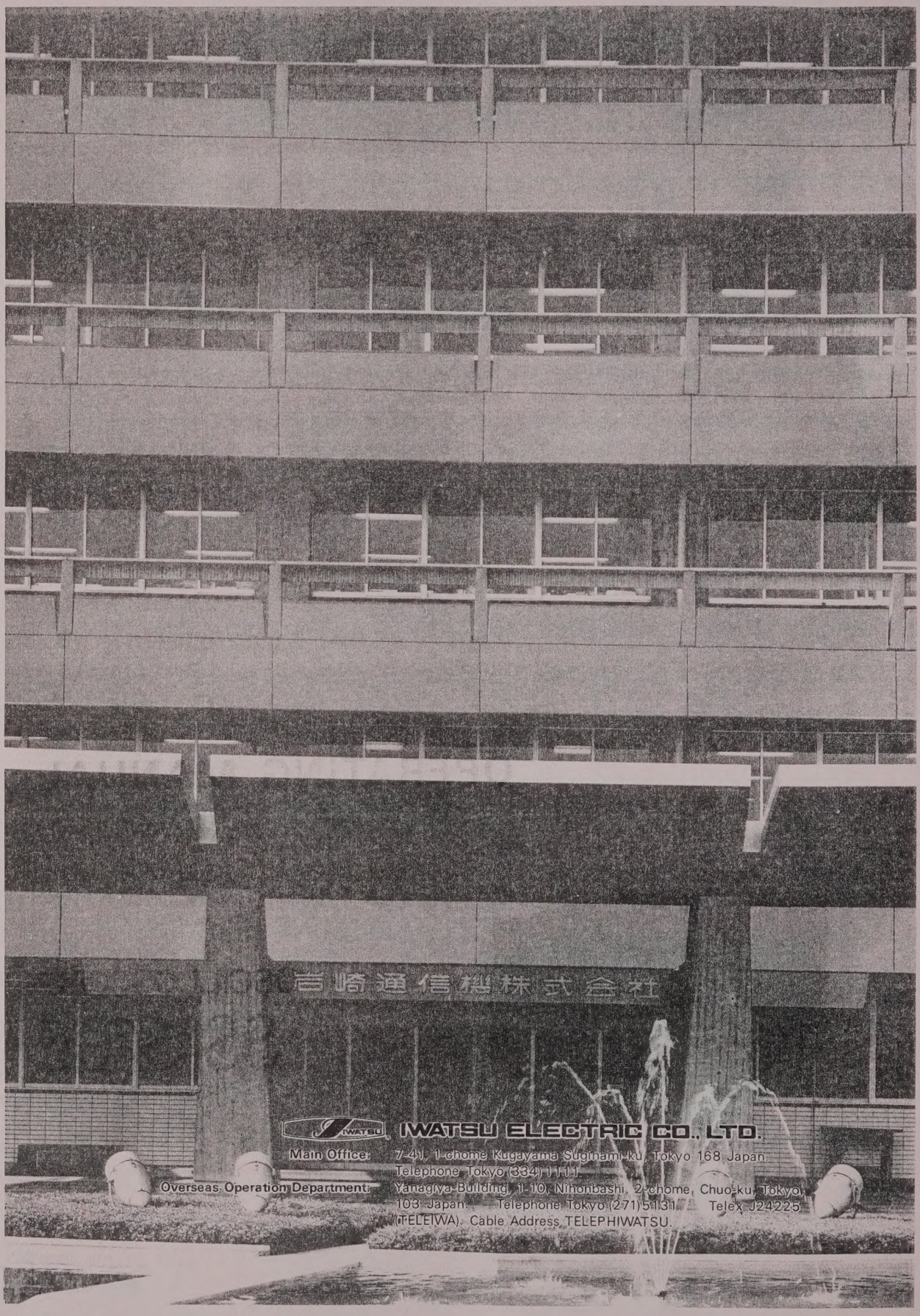


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TABLE OF CONTENTS

SECTION 1	**SPECIFICATIONS**	1-1
1-1	GENERAL	1-1
1-2	ELECTRICAL SPECIFICATIONS	1-2
1-2-1	Cathode-Ray Tube (CRT)	1-2
1-2-2	Vertical Deflection System	1-2
1-2-3	Triggering	1-3
1-2-4	Horizontal Deflection System	1-4
1-2-5	X-Y Operation	1-4
1-2-6	External Intensity Modulation	1-5
1-2-7	Calibrator	1-5
1-2-8	Power Supply	1-5
1-3	PHYSICAL CHARACTERISTICS	1-5
1-4	ENVIRONMENTAL CHARACTERISTICS	1-6
SECTION 2	**OPERATING INFORMATION**	2-1
2-1	PROCEDURE TO DISPLAY CAL WAVE	2-1
2-2	CONTROLS AND SWITCHES	2-3
2-2-1	Front Panel	2-3
2-2-2	Rear Panel	2-5
2-3	BASIC OPERATIONS FOR SIGNAL MEASURING	2-7
2-3-1	Line Voltage Selection	2-7
2-3-2	Trace or Spot Position Search (BEAM FIND)	2-7
2-3-3	How to Apply Signals (INPUT, probe)	2-8
2-3-4	Input Coupling Selection (AC-DC, GND)	2-8
2-3-5	Deflection Factor Setting (VOLTS/DIV, VARIABLE)	2-9
2-3-6	Sweep Rate Setting (A. B TIME/DIV, VARIABLE)	2-9
2-3-7	Triggering	2-10
2-3-8	Horizontal Axis Operation Selection	2-15
2-3-9	TRIG'D, RUNS AFTER DELAY, and DELAY TIME	2-15
2-3-10	TRACE SEPARATION	2-16
2-3-11	FINE (PULL x 10 MAG)	2-16
2-4	APPLIED OPERATIONS FOR SIGNAL OBSERVATION	2-17
2-4-1	Operation for Dual Trace Operation	2-17
2-4-2	Operation for Observing the Sum or Difference of Two Signals	2-18
2-4-3	Operation for Triple Trace Observation	2-19
2-4-4	Operation as X-Y Scope	2-20
2-4-5	Operation for Single Sweep Observation	2-21
2-4-6	Operation for Television Signal Observation	2-22
2-4-7	Operation for Waveform Magnification	2-23
2-4-8	Operation for ALT Sweep	2-24
2-4-9	External Intensity Modulation	2-25
2-5	OPERATION FLOW	2-27
SECTION 3	**MEASURING INSTRUCTIONS**	3-1
3-1	ADJUSTMENT NECESSARY BEFORE MEASUREMENT	3-1
3-1-1	TRACE ROTATION Adjustment	3-1
3-1-2	Probe Phase Adjustment	3-1
3-2	MEASURING METHODES	3-2
3-2-1	Voltage Measurement	3-2
3-2-2	Time Measurement	3-3
3-2-3	Frequency Measurement	3-4
3-2-4	Phase Difference Measurement	3-4

Do not increase light intensity excessively

Do not increase the light intensity of traces or spot more than necessary. Excessive light intensity can not only result in eyes fatigue but, if left for a long time, burn the CRT phosphor surface.

Using the SS-5705 with the CRT screen up

The SS-5705 can be used with the CRT screen up. Be careful not to bring the SS-5705 down by pulling hard the probes connected to the signal input connector.

Do not apply excessive voltage

The input voltage limit of each input connector is as follows:

CH 1-2-3 INPUT	400V (DC + peak AC)
Probe input	600V (DC + peak AC)
Z Axis INPUT	50V (DC + peak AC)

Do not apply voltage greater than this.

Connect protective ground terminal to ground

When using the attached two wire cord to supply line voltage from a two-wire power outlet, be sure to ground the ground terminals on the rear panel of SS-5705 for safety.

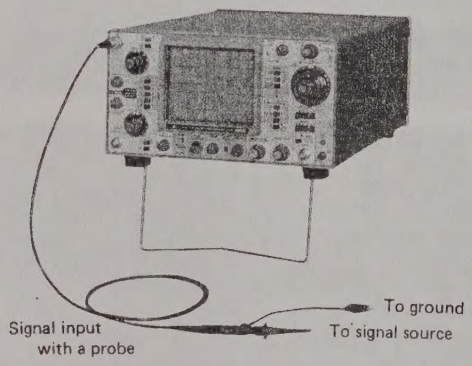
If an optional triple conductor cord is used to supply line current from a three-wire power outlet, grounding is performed by the power cord ground line.

Probe and input connector ground connections

When measuring a large input signal with a probe or a signal input cable, be sure to ground the probe and signal input connector to the signal source ground.

Do not connect the probe or the signal input cable ground to signal source because overcurrent will flow between the measuring instrument and signal source. This not only damages the probe and the signal input cable, but is also very dangerous.

Connection example



Specifications

1-1 GENERAL

The Iwatsu SS-5705 is 40 MHz triple event observation oscilloscopes.

Their precision and performance are comparable to high grade models and they can be used for a variety of measurement applications such as production line, maintenance, research, and development.

The SS-5705 has the following features:

- **High precision and stability**
  - Vertical and horizontal axis sensitivity is within ±2%. (at 10°C to 35°C)
  - High precision calibrator
    Frequency accuracy ±1% (at 10°C to 35°C)
    Voltage amplitude accuracy ±1% (at 10°C to 35°C)

- **Variety of high grade functions**
  - Highest acceleration voltage in its class 12 KV
    High intensity 6 inch rectangular CRT with illuminated scale
  - Displaying of 6 traces with the use of triple event alternate sweep function
  - Sweep delay function
    Usability not attainable with trigger delay method
  - Triple even display and ADD operation
    Vertical axis sensitivity magnification (CH-1) 1 mV/div
  - First in this class to use jitterless synchronization circuit
    Enables measurement of high speed signals with little or no jitters
  - Hold off variable function
    Effective when synchronizing with complicated signals.
    Video signal separation circuit
  - CH-1 signal output function
    Useful when use together with counter
  - Maximum sweep time of 10 ns/div
  - Single sweep function, beam finder function, trace rotation function
  - Fix synchronization circuit
- **Small and light weight**
- **Practical design for ease of operation**

1-2 ELECTRICAL SPECIFICATIONS

1-2-1 Cathode-Ray Tube (CRT)

Shape	Rectangular, 6 inches
Display Area	8 div x 10 div (1 div = 10 mm), with internal graticule of parallax-free type
Phosphor	B31
Accelerating Voltage	Approximately 12 kV

1-2-2 Vertical Deflection System

Modes	CH 1, CH2, ADD, DUAL/TRI (ALT, CHOP), X-Y CHOP switching rate: approximately 130 kHz
Channels 1 and 2	
Deflection Factor	5 mV/div to 10 V/div, in 11 calibrated steps in a 1-2-5 sequence Accuracy: ±2 % (at 10°C to 35°C) 5 mV/div to 25 V/div, continuously variable with the VARIABLE control x5 MAG 1 mV/div Accuracy: ±4 % (at 10°C to 35°C)
Frequency Response	DC to 40 MHz, −3 dB (5 mV/div to 0.2 V/div) DC to 20 MHz, −3 dB 1 mV/div, 2 mV/div (in the x5 MAG mode) Notes • 10°C to 35°C • AC coupling: The lowest usable frequency is 4 Hz.
Rise Time	8.75 nsec (5 mV/div)
Pulse Response	Overshoot: 7 % Sag (at 1 kHz): 2 % Other distortions: 5 % (5 mV/div, 10°C to 35°C)
Signal Delay	Delay cable supplied
Input Coupling	AC, DC, GND
Input RC	Direct: 1 MΩ ±2 %//32pF ±2pF With probe: 10 MΩ ±3 %//21pF ±3pF
Maximum Input Voltage	Direct: 400V (DC +peak AC) With probe: 600 V (DC +peak AC)
Drift	0.5 div/hour (5 mV/div) or 2.5 div/hour (1 mV/div) 30 minutes after power is turned on (Standard)
Common Mode Rejection Ratio	5 mV/div: 40: 1 (1 kHz sine wave) 15: 1 (5 MHz sine wave)
Polarity Inversion	CH 2 only

Channel 3

Deflection Factor	0.1 V/div Accuracy: ±3 % (at 10°C to 35°C)
Frequency Response	DC to 40 MHz, –3 dB Notes • 10°C to 35°C • AC coupling: The lowest usable frequency is 4 Hz.
Pulse Response	Overshoot: 10 % Sag (at 1 kHz): 3 % Other Distortions: 9 % (10°C to 35°C)
Input Coupling	AC, DC
Input RC	Direct: 1 MΩ ±2 %//32 pF ±8 pF With probe: 10 MΩ ±2 %//21 pF ±3 pF
Maximum Input Voltage	Direct: 400 V (DC +peak AC) With probe: 600V (DC +peak AC)

1-2-3 Triggering

Signal Source	CH1, CH2, CH3, LINE, (External trigger can be used by selecting CH3 with SOURCE switch.)
Coupling	AC, DC, HF REJ, LEVEL FIX, TV (A-sweep: TV-V, B-sweep: TV-H)
Slope	Positive-going (+), Negative-going (–)
Minimum Trigger Sensitivity	As shown in Table 1-2-3

Table 1-2-3 (at 10°C to 35°C)

Frequency Range	Sensitivity	
	CH1, CH2	CH3
DC to 5 MHz	0.5 div	1 div
5 MHz to 40 MHz	1.5 div (B: 2 div)	3 div

Note

- Fix: 1 div at 100 Hz to 5 MHz
  2 div at 5 MHz to 20 MHz
- In TV-mode, synchronization is achieved when amplitude is more than 1 div when composite signal consisting of video signal 7 and synchronization signal 3 is input.
- Trigger signals are attenuated in the following frequency ranges depending on coupling
  AC: 10 Hz or less
  HF REJ: 10 kHz or higher
- AUTO sweep mode: The lowest usable frequency is 50 Hz.

1-2-4 Horizontal Deflection System

Modes	A, A INTEN, B (DLY'D)
A-Sweep	
Sweep Modes	AUTO, NORM, SINGLE
Sweep Rates	0.1 μsec/div to 0.5 sec/div, in 21 calibrated steps in a 1-2-5 sequence
	0.1 μsec/div to 1.25 sec/div, continuously variable with the VARIABLE control
	Accuracy I (Over center 8 divisions): ±2 % (at 10°C to 35°C)
	Accuracy II (Over any 2 of the center 8 divisions): ±5 % (10°C to ±35°C)
Hold-Off Time	Variable with the HOLDOFF control
B-Sweep	
Delay	Continuous delay (RUNS AFTER DELAY), triggered delay (TRIG'D)
Sweep Rates	0.1 μsec/div to 50 msec/div, in 18 calibrated steps in a 1-2-5 sequence
	Accuracy I (Over center 8 divisions): ±3 % (at 10°C to 35°C)
	Accuracy II(Over 2 of the center 8 divisions): ±5 % (at 10°C to +35°C)
Delay Jitter	1/20,000 or less
Sweep Magnification	10 times
	(Maximum sweep rate: 10 nsec/div)
	Accuracy I of magnified sweep rate (Over center 8 divisions); ±4 % (at 10°C to 35°C)
	Exclude the first 2 divisions for 10 nsec/div.
	Accuracy II of magnified sweep rate (Over any 2 of the center 8 divisions): ±5 % at 100 nsec/div to 50 nsec/div (at 10°C to 35°C)

1-2-5 X-Y Operation

X Axis	
Signal Input	X axis: CH1, Y axis: CH2
Deflection Factor	Same as that of CH1
	Accuracy: ±5 % (at 10°C to 35°C)
Frequency Response	DC to 2 MHz, −3 dB
Input RC	Same as that of CH1
Maximum input voltage	Same as that of CH1
Y Axis	Same as CH2
X-Y Phase Difference	3° or less (at DC to 50 kHz)

1-2-6 External Intensity Modulation

Input Voltage	3 Vp-p
Polarity	Positive decleases intensity negative incleases intensity
Frequency Range	DC to 1 MHz
Input Resistance	10 kΩ ±20 %
Maximum Input Voltage	50 V (DC +peak AC)

1-2-7 Calibrator

Waveform	Square wave
Repetition Frequency	1 kHz
	Accuracy: ±1 % (at 10°C to 35°C)
Duty Ratio	40 % to 60 %
Output Voltage	0.3 V
	Accuracy: ±1 % (at 10°C to 35°C)
CH1 Signal Output	
Output Voltage	50 mV ±20 per displayed amplitude division
Bandwidth	DC to 20 MHz, −3 dB

1-2-8 Power Supply

Voltage Range	100 V (90 to 110 V)/115 V (103 to 128 V)/220 V (195 to 242 V)/230, 240 V (207 to 264 V)/AC
	One of these voltage ranges can be selected with voltage selector plug (A, B, C, D)
Frequency Range	50 to 440 Hz
Power Consumption	Approximately 48 W (at 100 VAC)

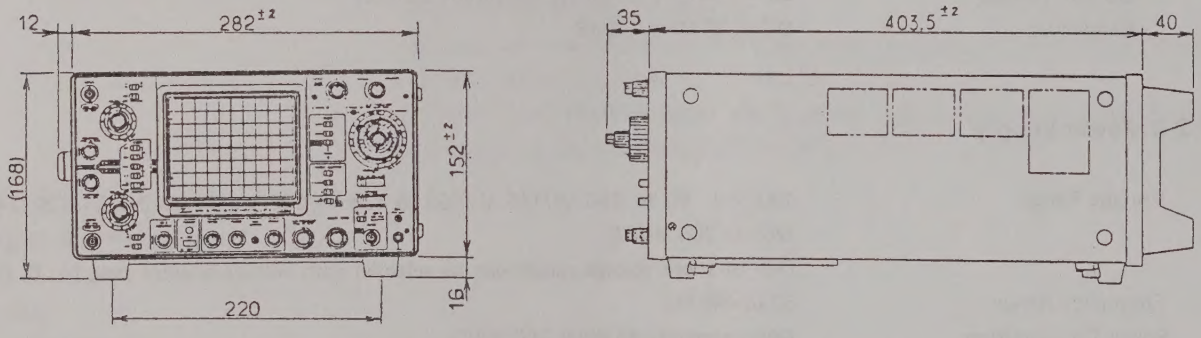
1-3 PHYSICAL CHARACTERISTICS

Weight	Approximately 7.2 kg
Dimensions	282 ±2 (W) x 152 ±2 (H) x 403 ±2 (L) (mm)
	See Figure 1-3-1.

1-4 ENVIRONMENTAL CHARACTERISTICS

Operating Temperature	0°C to 40°C
Operating Humidity	40°C, 90 % Relative Humidity
Storage Temperature	−20°C to 70°C
Storage Humidity	70°C, 80 % Relative Humidity
Altitude	Operating: 5,000 m maximum (atmospheric pressure 428 mmHg) Non-operating: 15,000 m maximum (atmospheric pressure 87 mmHg)
Vibration	From 10 Hz to 55 Hz and back in 1 minute; double amplitude 0.63 mm: for 15 minutes each in vertical, horizontal, and longitudinal directions for a total of 45 minutes
Impact	One side is raised to an elevation angle of 30° (10 cm maximum), and let fall on a piece of hard wood. Each side is put to this test 3 times.
Drop	A package ready for transporation is dropped from a height of 90 cm.

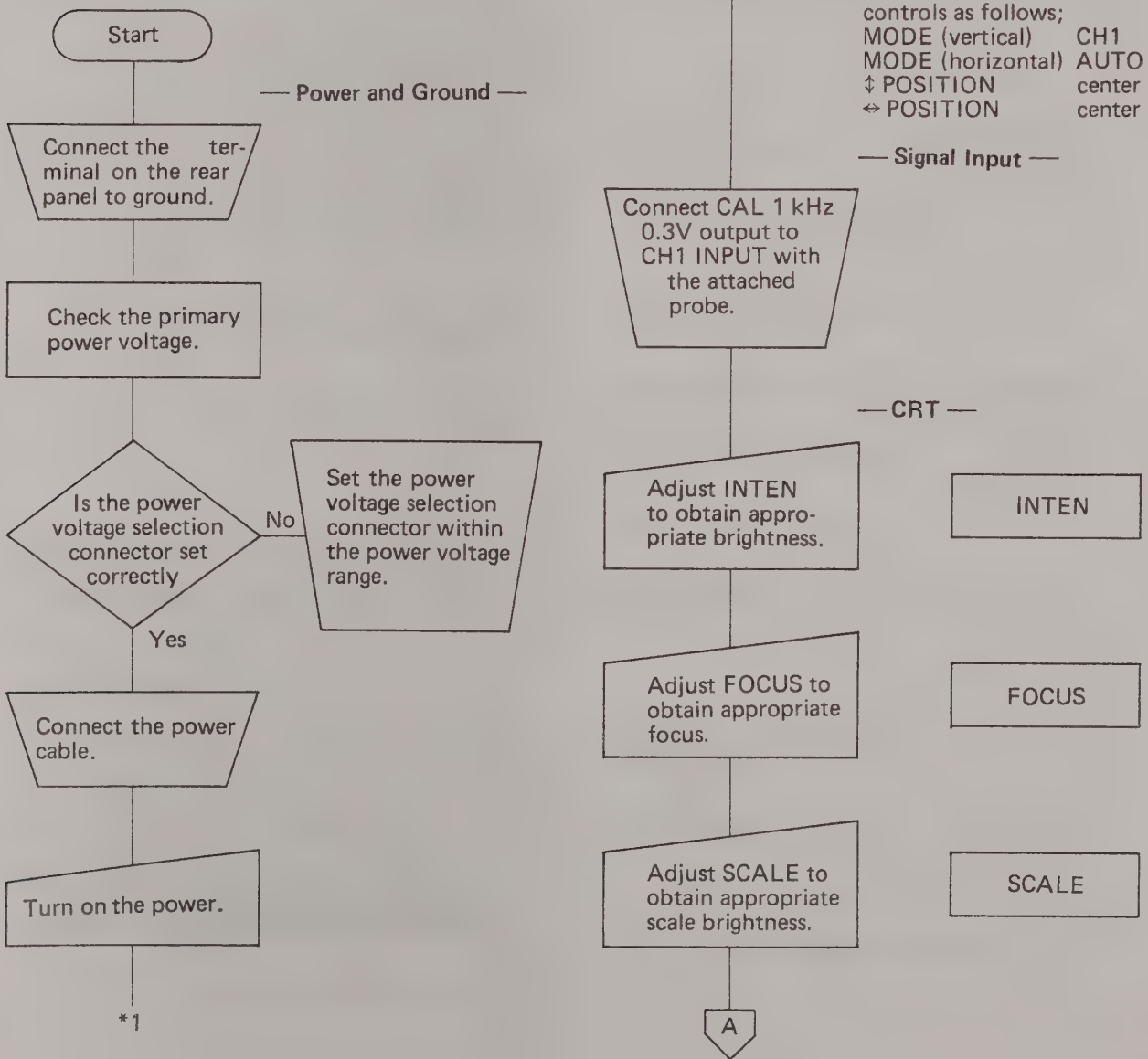
Figure 1-3-1. Dimensional Diagram



Operating Information

2-1 PROCEDURE TO DISPLAY CAL WAVE

The following operation flowchart shows the procedure for displaying CAL wave by connecting CAL 1 kHz 0.3V output to CH1 INPU using the attached prode.


Start
— Power and Ground —
Connect the terminal on the rear panel to ground.
Check the primary power voltage.
Is the power voltage selection connector set correctly
No
Set the power voltage selection connector within the power voltage range.
Yes
Connect the power cable.
Turn on the power.
*1
*1
Switches and controls setting.
a
a: Set the switches and controls as follows;
MODE (vertical) CH1
MODE (horizontal) AUTO
↕ POSITION center
↔ POSITION center
— Signal Input —
Connect CAL 1 kHz 0.3V output to CH1 INPUT with the attached probe.
— CRT —
Adjust INTEN to obtain appropriate brightness.
INTEN
Adjust FOCUS to obtain appropriate focus.
FOCUS
Adjust SCALE to obtain appropriate scale brightness.
SCALE
A

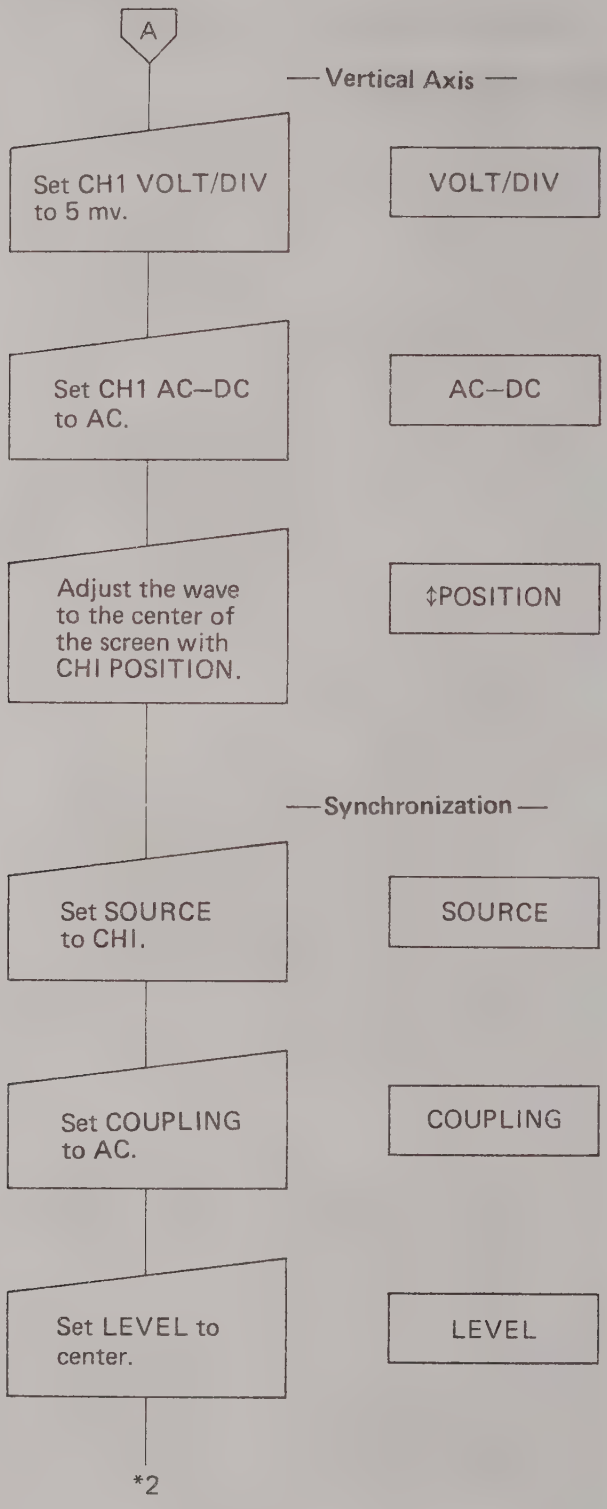
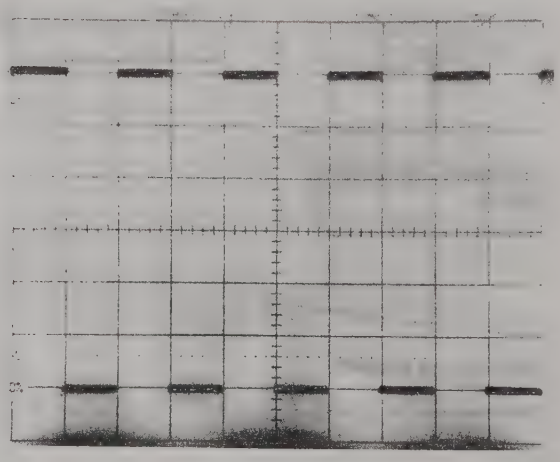


Figure 2–1–1 CAL Wave Shape



Select CH1 input connection type.

Input CH1 measured signal.

Illuminates

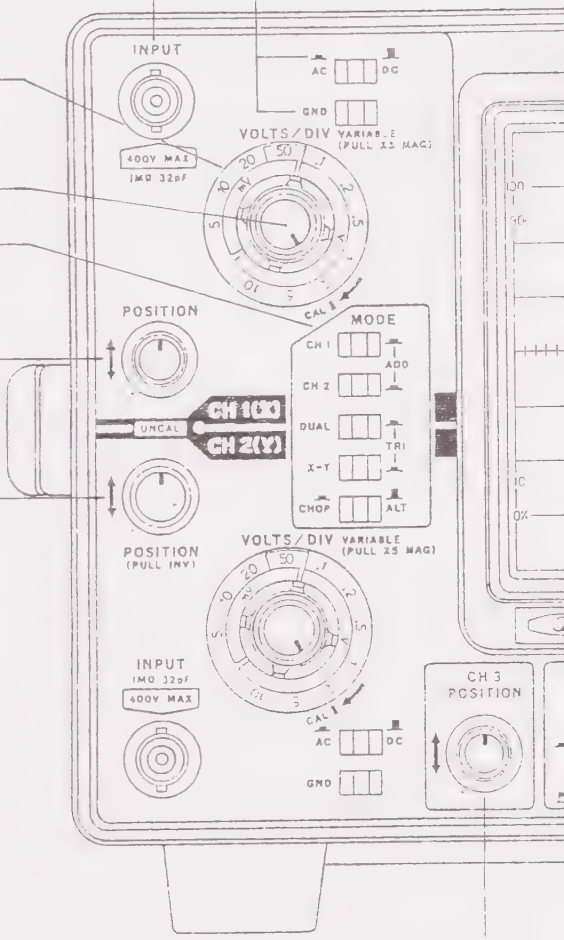
Set vertical axis input sensitivity.

Continuosly chage vertical axis input sensitivity.
Move CH1 wave shape in the vertical magnified
5 times when pulled.

Select vertical axis operation.

Move CH1 wave shape in the vertical direction.
The polarity of the input signal reverses when
pulled.

Move CH2 wave shape in the vertical direction.
The polarity of the input signal reverses when
pulled.



Move CH3 wave shape in the vertical direction.

Turn on or off the power.

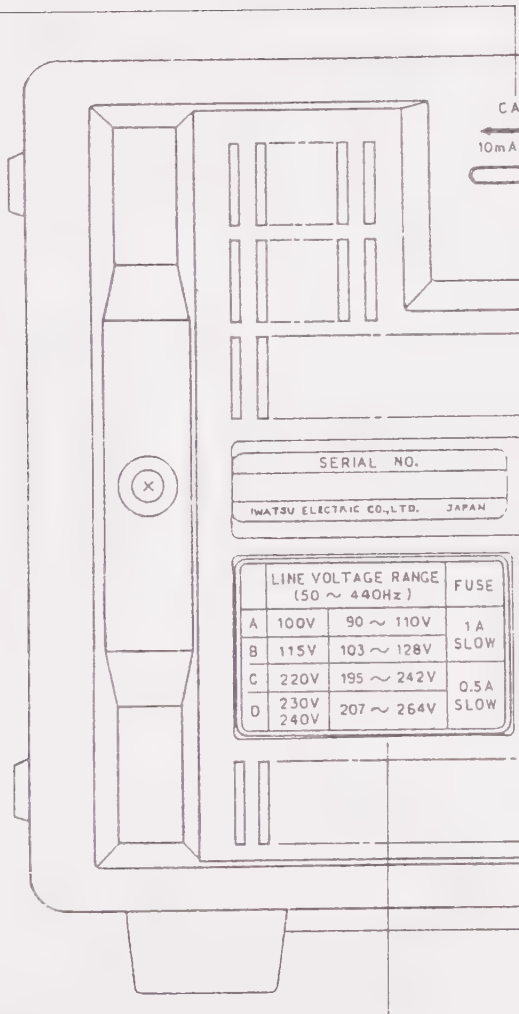
Adjust brightness of displayed wave shape. Spot or line is displayed in the center when pressed.

Adjust focus of displayed wave shape.

Adjust curving of displayed line.

Adjust bringtness of displayed scale.

Obtain calibration current wave shape.

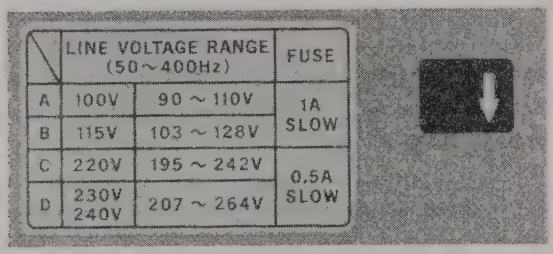

CA
10mA
SERIAL NO.
IWATSU ELECTRIC CO.,LTD. JAPAN
LINE VOLTAGE RANGE (50 ~ 440Hz)
FUSE
A 100V 90 ~ 110V 1A SLOW
B 115V 103 ~ 128V
C 220V 195 ~ 242V 0.5A SLOW
D 230V 240V 207 ~ 264V

Indicates power voltage, operating range, and fuse specifications.

Select power voltage.

2-3 BASIC OPERATIONS FOR SIGNAL MEASURING

2-3-1 Line Voltage Selection



The voltage select plug on the rear panel can be pulled out and reinserted after removing the rear panel. The letters A, B, C, and D printed around the plug correspond to the letters A, B, C, and D printed on the LINE VOLTAGE RANGE plate on its left.

After checking which of the letters A, B, C, and D in the LINE VOLTAGE RANGE plate represents the primary line voltage to be applied to operate this device, reinsert the voltage select plug so that the arrow points the correct letter.

> CAUTION
>
> Be sure to unplug the power cord from the electrical outlet before reinserting the voltage select plug.

2-3-2 Trace or Spot Position Search (BEAM FIND)

MODE (Vertical):
Other than X-Y
MODE (Horizontal):
AUTO

Set the panel switches as shown above, and press the power switch on.

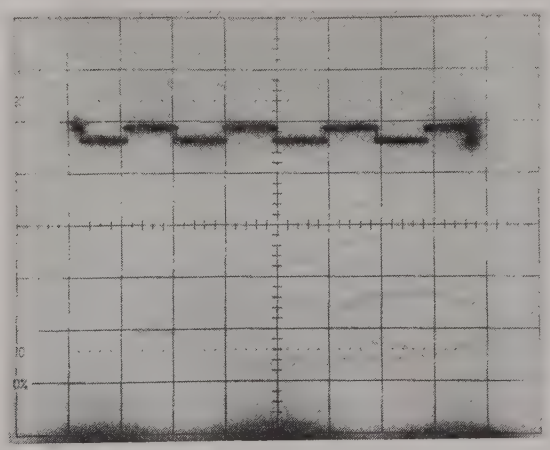
If the primary line voltage is supplied to the device and if the POSITION controls ↕ (Vertical) and ↔ (Horizontal) are positioned nearly at the center, turn the INTEN control clockwise about 15 to 20 seconds later, and a trace appears. (If the vertical MODE X-Y is selected, a spot appears.) If the POSITION control ↕ or ↔ is turned clockwise or counterclockwise from the center position to a point where a trace or spot will be outside the CRT screen, no trace or spot appears.

In such a case, press the INTEN (PUSH BEAM FIND) control.

When the INTEN control is pressed, a trace or spot outside the CRT screen appears near the center of it.

If the INTEN control is pressed when a trace or spot is in the upper part of the CRT screen, the trace or spot appears above the centerline of the graticule, indicating that it is in the upper part of the screen. Keep the INTEN control pressed, move the trace or spot to the center of the screen with POSITION ↕, and release the INTEN control. The trace or spot is shown in the center of the screen.

Figure 2-3-2. Example of display of on CRT screen when INTEN (PUSH BEAM FIND) is pressed



2-3-3 How to Apply Signals (INPUT, probe)

Apply signals to be measured to the INPUT connectors for channels 1, 2, and 3, using a probe.

The use of a probe reduces the adverse effect of external fields on the signals measured.

The SS-5705 is provided with a Model SS-0060 probe (1.5 m long), with attenuation ratios of 10 to 1 and 1 to 1 selectable with a switch, as an accessory.

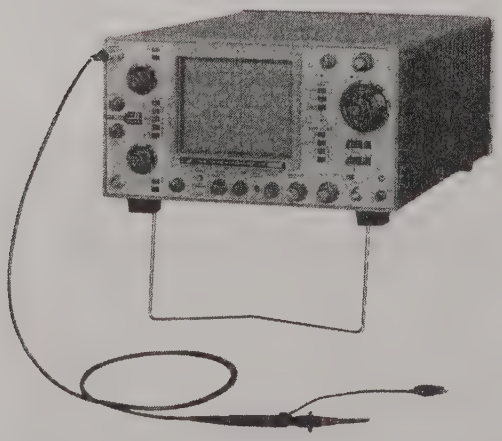
Input impedance is higher when the probe is used at the attenuation ratio of 10 to 1 than when it is used at the attenuation ratio of 1 to 1 or when the probe is not used so that the load effect on the signal source is reduced. Even if the signal source has a relatively high impedance, therefore, signals can be measured accurately.

If the probe is used at 10 to 1, however, the input signal is attenuated to one-tenth so that, in measuring the amplitude of the input signal, the values indicated by the channels 1 and 2 VOLTS/DIV switches, or the value indicated for channel 3 must be multiplied by ten.

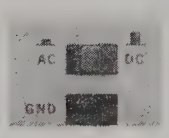
If the probe is used at 1 to 1 in measuring high-frequency signals, a large load effect will be produced on them. That is, the use of the probe at the attenuation ratio of 1 to 1 is suitable for measuring low-frequency, low-level signals.

(For detailed information on the probe, refer to the instruction manual for the probe.)

Figure 2-3-3. Example of probe connection



2-3-4 Input Coupling Selection (AC-DC, GND)



There are many types of signals to be measured, including DC, AC, and AC superimposed on DC signals. To correct measure these signals, it is necessary to select the proper signal input coupling, using the AC-DC switch. This switch is used for selecting a type of signal input coupling for the vertical axis. When the switch is pressed to the AC position, the AC coupling in which the INPUT connectors are connected via a capacitor to the input of the vertical amplifier is selected. If the switch is released to the DC position, the DC coupling in which the INPUT connectors are directly connected to the vertical amplifier is selected. With switches S02 (CH1) and S05 (CH2) at GND, input signals are not connected to the vertical amplifier, but the input of the vertical amplifier is grounded.

AC Coupling

When the AC-DC switch is pressed to the AC position, only the AC signal component of superimposed on DC signal input is allowed to pass, while the DC signal component is blocked by the capacitor. Even if the deflection factor is raised, therefore, the AC signal waveform will not be moved out of the CRT screen by the DC (signal offset), but can be observed with its amplitude magnified on the screen. If a signal with a low repetition frequency is observed in the AC coupling mode, a sag occurs if the signal is a square wave, or the signal is shown attenuated in amplitude. This attenuation is about -3 dB per 4 Hz.

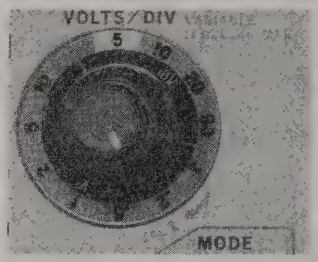
DC Coupling

When the AC-DC switch is released to the DC position, all the frequency components of the input signal are allowed to pass. Normally, this mode should be used except when blocking the DC components of the input.

Ground (GND)

When switch S02 or S05 is at GND, the input of the vertical amplifier is grounded so that a ground potential is displayed on the CRT screen. This potentially is normally used as the reference potential in measuring signals.

2-3-5 Deflection Factor Setting (VOLTS/DIV, VARIABLE)



To display and measure a signal on the CRT screen, it is necessary to show it in an appropriate amplitude on the screen. Correct measurement cannot be expected if the amplitude on the CRT screen is too small or so large that it extends beyond the limits of the screen. Therefore, the deflection factor must be increased if the input signal has too small an amplitude, or decreased if it has too large an amplitude. The switches for channels 1 and 2 VOLTS/DIV, which have a fine control called VARIABLE are used for varying the deflection factor.

If the VARIABLE control is turned fully clockwise to the CAL position, the deflection factor is directly indicated by the VOLTS/DIV switches.

VOLTS/DIV indications represent voltages per division of the amplitude of a signal waveform displayed on the CRT screen. Turning VARIABLE counterclockwise decreases the deflection factor. When VARIABLE is fully turned counterclockwise, each position represents 1/2.5 (or less) of the value indicated.

The deflection factor for channel 3 is fixed at 0.1 V/division. No fine control is provided for channel 3.

2-3-6 Sweep Rate Setting (A.B TIME/DIV, VARIABLE)

Signals to be measured may include a low-frequency signal, high-frequency signal, and a pulse with a slow rise or quick rise. It is necessary to select a sweep rate suitable to the signal to be measured.

Lower the sweep rate when measuring, for example, a low-frequency signal, or a pulse with slow repetition, and raise the sweep rate when measuring, for example, a high-frequency signal, or a pulse with a quick rise.

The switch for sweep rate selection in sweep A is A TIME/DIV, which has a fine control called A VARIABLE.

When the A VARIABLE control is fully turned clockwise to the CAL position, the A TIME/DIV switch directly indicates a sweep rate. Turning the A VARIABLE control counterclockwise lowers the sweep rate. When it is fully turned counterclockwise, each position represents 2.5 times or less of the value indicated.

The switch for sweep rate selection in sweep B is B TIME/DIV, which has no fine control.

2-3-7 Triggering

The operation for displaying a signal to be measured still on the CRT screen is called triggering. It is described in this section.

The following six steps of operation are necessary for triggering.

(1) Trigger mode selection
Select either the horizontal MODE AUTO or NORM.

(2) Trigger signal source selection
Select a trigger signal with SOURCE.

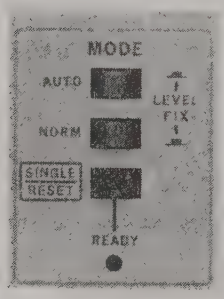
(3) Trigger coupling selection
Select a coupling mode with COUPLING.

(4) Slope selection
Push LEVEL for positive trigger slope or pull it for negative trigger slope.

(5) Trigger level selection
Select a suitable trigger level in the tirgger level range.

(6) Hold-off adjustment
This adjustment is made for stabilized triggering of the waveform of a complex pulse line.

(1) Trigger mode selection (MODE)



The SS-5705 has two trigger modes: AUTO and NORM, each of which can be selected with the horizontal MODE buttons.

AUTO: A desired trigger level can be set with the LEVEL control.
If the set trigger level is within the trigger level range (see (4) Slope Selection), the input signal is triggered.
If the set trigger level is outside the trigger level range, or if no trigger signal is available, a free running sweep takes place.
Therefore, a signal too small to provide sufficient amplitude can be easily checked, and the ground potential can be easily confirmed by grounding the input.

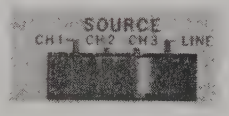
Input signals of 50 Hz or below will not be synchronized. In this case, use the NORM mode mentioned below.

NORM: If the set trigger level is within the trigger level range, the input signal is synchronized as in the AUTO mode, but if it is outside the trigger level range or if no trigger signal is available, there will be no sweep.

SINGLE: Only a single sweep takes place. When the SINGLE/RESET button is pressed once, the device stands by for the start of a sweep. If the same button is pressed again when the input signal is synchronized and when the A TRIG'D lamp is lighted, a single sweep takes place.

This mode is used when photographing waveforms on the CRT screen or observing attenuated waveforms.

(2) Trigger signal source selection (SOURCE)



Triggering requires applying an input signal, or a signal which has a specific time relationship (an integer or times an integer) with the input signal (called a trigger signal), to the trigger circuit to drive it to generate a trigger pulse and drive the sweep circuit with it.

The method of applying the input signal applied to INPUT to the trigger circuit via internal circuits (half way in the vertical deflection system) is called Internal Trigger.
Internal Trigger is selected when SOURCE is set to CH 1 or CH 2. In Internal Trigger, an input signal is internally connected to the trigger circuit when it is half way in the vertical deflection system. Thus, if it is directly applied to INPUT, though it may be a low-voltage input signal, it is amplified to an appropriate voltage level, and automatically routed to the trigger circuit.

This means simple operation and no need for lowering the output impedance of the trigger signal source as in External Trigger. Internal Trigger is normally more convenient than External Trigger for these advantages. To select a trigger signal for Internal Trigger, set SOURCE to CH 1 so that the input signal that is applied to the INPUT connector for channel 1 is routed to the trigger circuit. If SOURCE is set to CH 2, the input signal that is applied to the INPUT connector for channel 2 is routed to the trigger circuit. In measuring two input signals of the same frequency, selection of the channel to which the input signal that has the higher voltage and less noise than the other is applied provides higher trigger stability.

In measuring two input signals having different frequencies as shown in Figure 2-3-7-(2), it is necessary to select the channel to which the input signal of the lower frequency is applied (provided that their relationship is that of times an integer). If the other channel is selected, the waveform of the input signal that has the lower frequency will not be triggered. In the case shown in Figure 2-3-7-(2), for example, a pulse must be used for triggering. If a sawtooth wave is used for this purpose, a pulse wave cannot be triggered. In measuring a phase difference, it is necessary to select the channel to which the signal that has the advanced phase is applied.

The method of applying an external input signal or a signal having a specific time relationship with the input signal to the trigger circuit is called External Trigger.

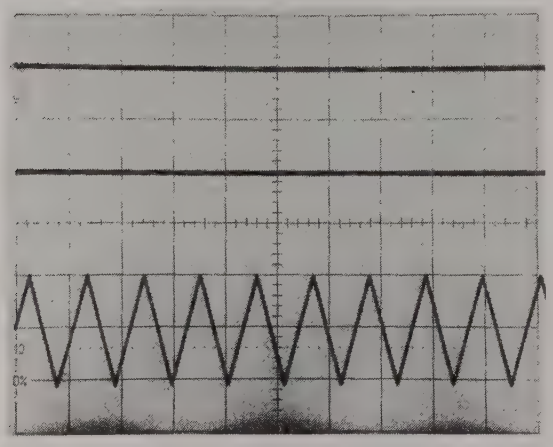
If SOURCE is set to CH 3 and if a signal that has a time relationship with the signal applied to the INPUT connector for channel 1 or 2 is applied to the INPUT connector for channel 3, the input signal applied to the INPUT connector for channel 1 or 2 can be triggered by the input signal to channel 3. Also, quantitative measurement is possible by displaying the input signal on the CRT screen. The advantages of Internal Trigger are directly the disadvantages of External Trigger, but External Trigger provides the following advantages that can hardly be disregarded.

First, External Trigger is unaffected by the vertical deflection system. In Internal Trigger, the voltage applied to the trigger circuit varies as VOLTS/DIV is turned. In the sweep mode NORM, however, LEVEL must be adjusted each time VOLTS/DIV is turned depending on the input signal waveform. In External Trigger, however, accurate triggering is assured once satisfactory triggering is obtained no matter how the VOLTS/DIV switch is turned unless the external trigger signal waveform changes.

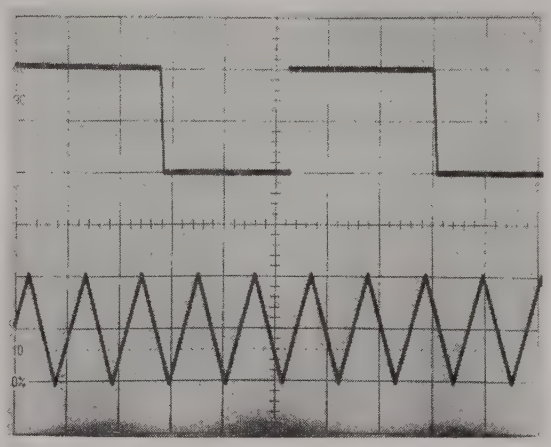
Second, if a sweep is desired a specific time before or after an input signal waveform appears, and if a signal is obtained at the point before or after that specific time, this signal may be applied to the INPUT connector for channel 3 for measuring the input signal waveform.

The method of applying a divided line voltage to the

Figure 2-3-7-(2). Triggering signals of different frequencies



(a) Trigger by sawtooth wave



(b) Trigger by pulse

trigger circuit is called Line Trigger.

Line Trigger is selected when SOURCE is set to the LINE position.

Line Trigger assures stable trigger in measuring line frequencies or line frequency harmonics regardless of the vertical deflection system because the line voltage is divided for use as a trigger signal.

(3) Trigger coupling selection

Use COUPLING to select a trigger signal input circuit coupling mode.

The purpose of it is to stably triggering an AC signal, DC signal, or a signal superimposed on harmonic noise and display its waveform on the CRT screen.

AC: This mode puts the trigger circuit in AC coupling, in which only the AC component of the trigger signal is used for triggering. Because the DC component of the trigger signal is cut off, synchronization can be established regardless of the DC component of the trigger signal.

AC coupling is generally convenient except when the trigger signal has a frequency below 10 Hz, in which case it is difficult to trigger.

DC: This mode puts the trigger circuit in DC coupling, in which a DC may be used for triggering. If an AC signal is superimposed or the DC trigger signal, or if its DC voltage is outside the range set with the LEVEL control, it cannot be used for triggering.

HF REJ: In this mode, the trigger circuit is coupled via the lowpass filter. A high-frequency trigger signal (about 10 kHz or over) or a trigger signal mixed with high frequency noise is attenuated by the filter which passes only the low-frequency component of the trigger signal.

LEVEL FIX: LEVEL FIX is selected when both MODE (horizontal) switches AUTO and NORM are simultaneously pushed in.

If LEVEL FIX is selected, trigger level (refer to (4) LEVEL setting) is set close to 0 V so that, if a trigger signal of a specific level or higher is input, synchronization is automatically established without operating the LEVEL control. Thus, trigger operation is extremely easy and accurate, but a fixed trigger level means it cannot be changed as desired.

The minimum amplitude required for triggering varies depending on the frequency as follows:

100 Hz to 5 MHz: 1 division or more

5 MHz to 10 MHz: 2 divisions or more

TV: This mode couples the trigger circuit for stabilized synchronization of television signals. (For measuring television signals, refer to 2-4-6 Operation for TV signal measuring.

Figure 2-3-7-(3). Trigger signal input circuit SOURCE and COUPLING

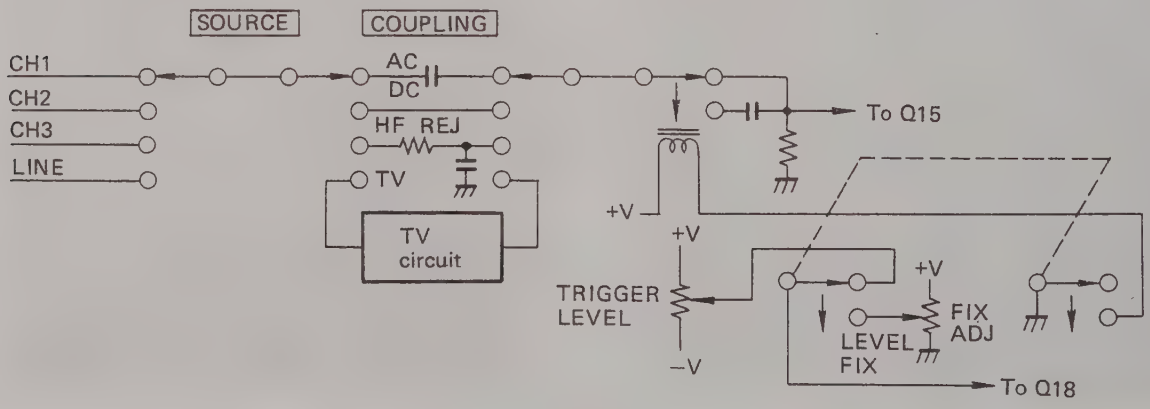
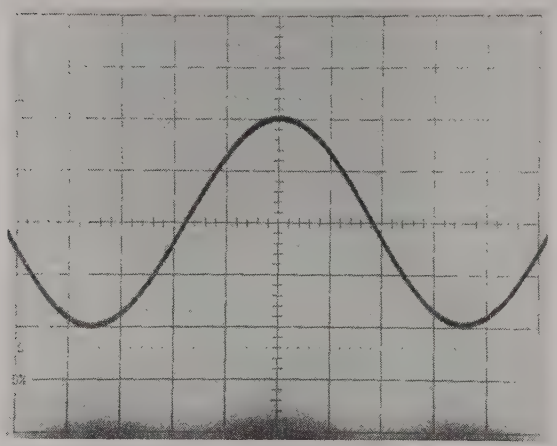
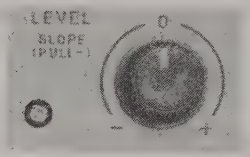


Figure 2-3-7-(4). Trigger signal slope



(4) SLOPE selection (SLOPE)



Select either positive slope or negative slope for the trigger signal to be used for triggering. Push LEVEL in for selecting positive slope, or pull it for selecting negative slope.

(5) Trigger level selection (LEVEL)

Trigger level must be set within the specified trigger level range (refer to Figure 2-3-7-(5)) for proper triggering. Proper trigger condition is indicated by the lighting of the A TRIG'D lamp.

Figure 2-3-7-(5). Trigger level

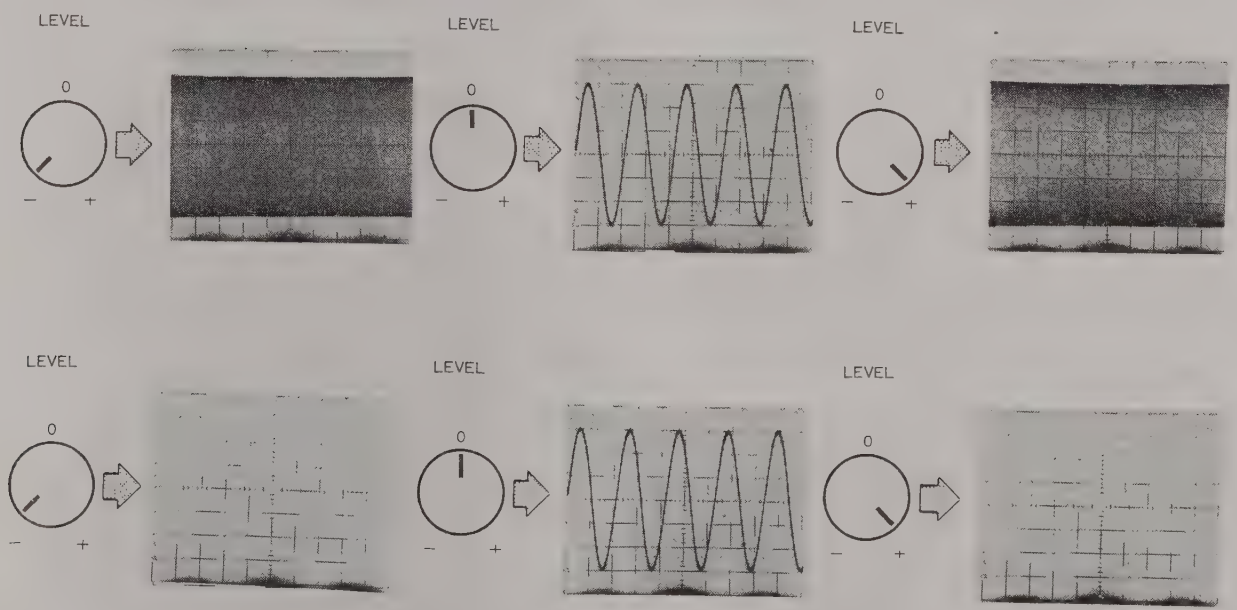


Figure 2-3-7 shows trigger levels set when the positive and negative trigger slopes are selected by use of the LEVEL control.

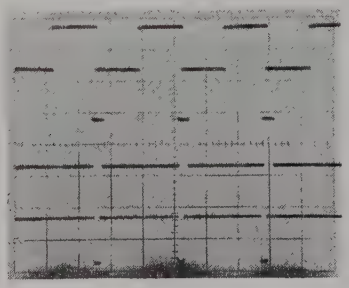
The four waveforms on the CRT screen start sweeping at the trigger level position selected with the LEVEL control.

(6) HOLD OFF

In observing the waveform of a complex line of pulses, the waveform may appear doubled despite synchronization depending on sweep rate setting.

In such a case, fully turn the HOLD OFF control from the counterclockwise extremity in the direction of INCREASE to adjust the sweep cycle so that the sweep always starts on the basic cycle of the signal. The waveform then appears in a way easy to observe.

Figure 2-3-7-(6). Example of measuring complex pulse train



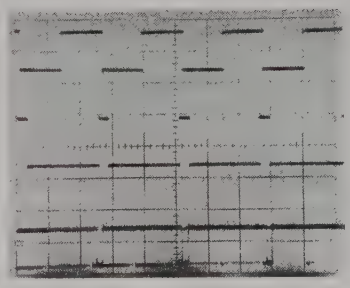
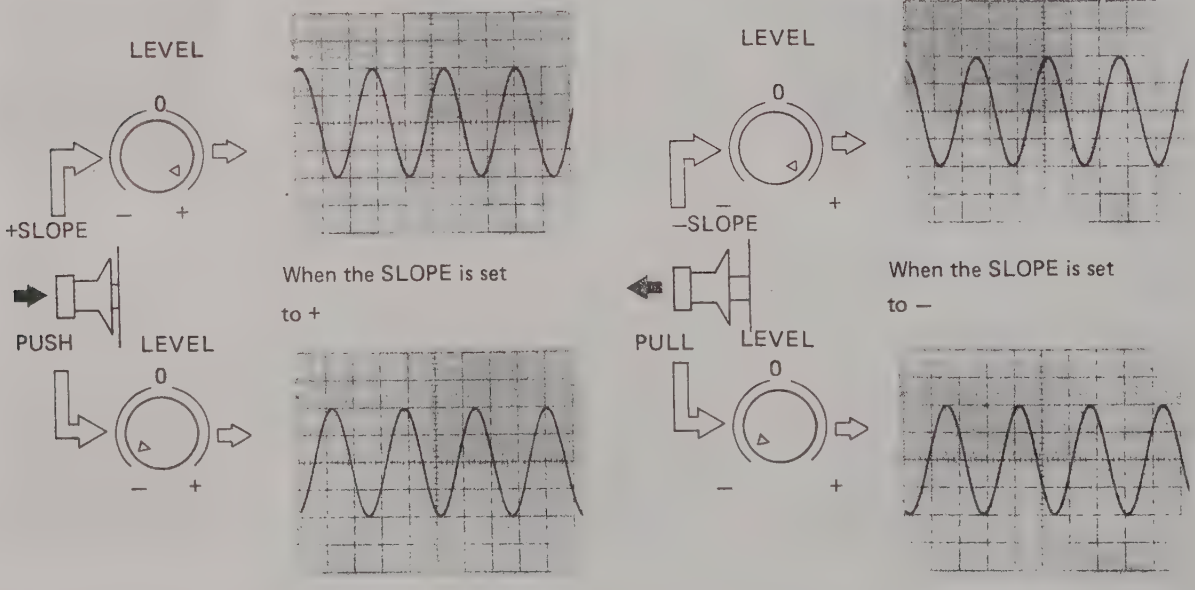
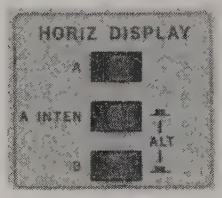


Figure 2-3-7. Trigger level and slope



2-3-8 Horizontal Axis Operation Selection



Select a horizontal axis sweep mode.

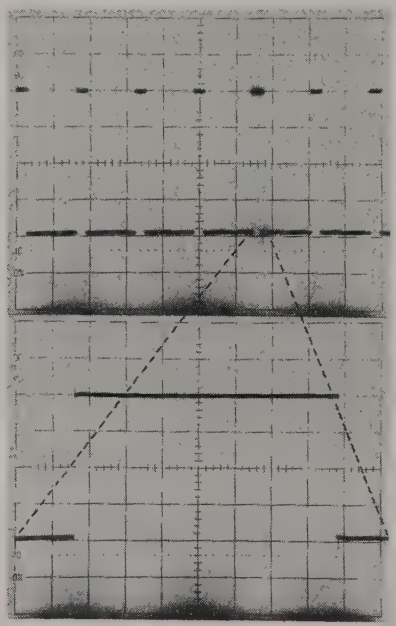
A: The A-sweep circuit is used for sweep. A sweep rate can be selected with the A TIME/DIV and VARIABLE.

A INTEN: The B-sweep is intensity-modulated and displayed on the A-sweep to check the start position of the B-sweep (delay sweep) and sweep length. A sweep rate can be selected with the A TIME/DIV and B-sweep width (sweep rate) with the B TIME/DIV.

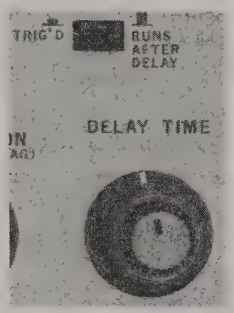
B: The B-sweep circuit is used for sweep. The intensity modulated part (B-sweep rate) in the INTEN sweep mode is displayed fully magnified on the CRT screen. The B TIME/DIV is used for sweep rate selection.

ALT: This mode alternates A INTEN sweep and B-sweep.

Figure 2-3-9. Example of delay sweep display



2-3-9 TRIG'D, RUNS AFTER DELAY, and DELAY TIME



The delay sweep function is used to display magnified a part of the signal to be measured a specific time after the sweep start point.

The A TIME/DIV and DELAY TIME are used for delay time setting, and the A.B TIME/DIV for magnification selection.

If an A-sweep of 1 ms/division, for example, is selected in Figure 2-3-9, a delayed sweep starts 6.3 divisions after the start point of the A-sweep. Thus, 1 ms/division x 6.3 divisions = 6.3 ms.

If a B-sweep of 50 μs/division is selected, the magnification ratio will be $\frac{1\text{ ms/division}}{50\ \mu\text{s/division}}$, that is, 1 to 20.

Two delay sweep modes, i.e., Trigger Delay and Runs After Delay, are available, and can be selected with the button TRIG'D (▬) – RUNS AFTER DELAY (▙).

TRIG'D: B-sweep is triggered by the first trigger pulse coming after the delay time selected with the A TIME/DIV and DELAY TIME.

This mode is used if delay jitters appear in the waveform on the CRT screen in the RUNS AFTER DELAY mode which is described below.

If a regularly repeating sine wave or square wave is input, the waveform may appear still even through the DELAY TIME is turned, but delay time changes.

RUNS AFTER DELAY: Delay time can be selected as desired. This mode offers the advantage that a B-sweep can be started at any point of an A-sweep. If the magnification ratio is increased so much, however, delay jitters appear on the CRT screen.

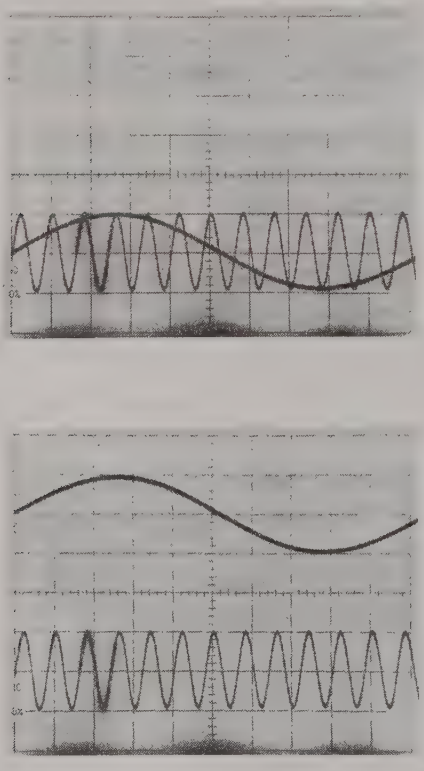
2-3-10 TRACE SEPARATION

This function is effective only when the HORIZ DISPLAY mode ALT is selected.

Waveforms displayed by the A INTEN sweep and B-sweep functions can be separated in the vertical direction.

When the control is fully turned counterclockwise, the waveforms displayed by the A INTEN sweep and B-sweep functions appear overlapped. When the control is turned clockwise, the waveform displayed by the B-sweep function moves.

Figure 2-3-10. Waveform display by TRACE SEPARATION

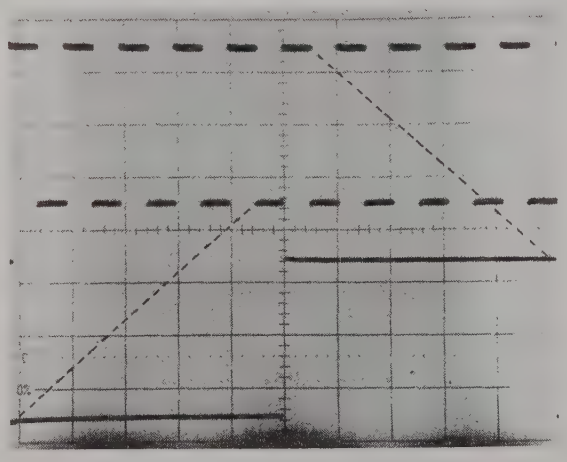


2-3-11 FINE (PULL x10 MAG)

Waveforms shown on the CRT screen can be horizontally magnified ten times.

Waveforms are horizontally magnified from the center of the graticule on the CRT screen so, first adjust the waveform to the center of the graticule with the ↔ POSITION control and next, pull the FINE control.

Figure 2-3-11. Example of waveform display by FINE (PULL x10 MAG)



2-4 APPLIED OPERATIONS FOR SIGNAL OBSERVATION

The oscilloscope has various convenient functions for observing signals. After mastering the basic operations, applied operations using these functions for observing signals can be performed as follows:

2-4-1 Operation for Dual Trace Observation

There are two modes of operation, ALT (alternate sweep) and CHOP (chopped sweep), for dual trace observation.

Dual traces of high- to low-frequency signals can be observed by using these ALT and CHOP modes.

In observing dual traces, first press the vertical axis MODE button DUAL, and select ALT or CHOP with the CHOP (▬) – ALT (▮) switch.

Dual trace observation in the ALT mode

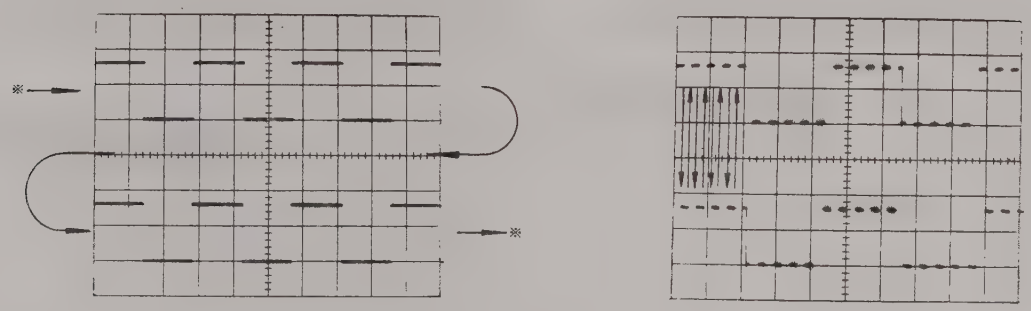
This mode is suitable for observing two signals of high frequency. In the ALT mode, channels 1 and 2 are alternated in sweep so that dual traces can be observed by applying two signals to be observed to the INPUT connectors for channels 1 and 2.

Alternate sweeps are possible in the full range of TIME/DIV, but lowering the sweep rate causes a flickering, which makes dual trace observation difficult. In observing signals that have a low repetition frequency, use the CHOP mode described below.

Dual trace observation in the CHOP mode

The CHOP mode is suitable for dual trace observation of low-frequency signals. In this mode, channels 1 and 2 are switched from one to the other at about 130 kHz so that, unlike in the ALT mode, it is difficult to observe high-frequency signals because their traces appear like dotted lines.

Figure 2-4-1. Displayed waveforms in ALT and CHOP modes



2-4-2 Operation for Observing the Sum or Difference of Two Signals

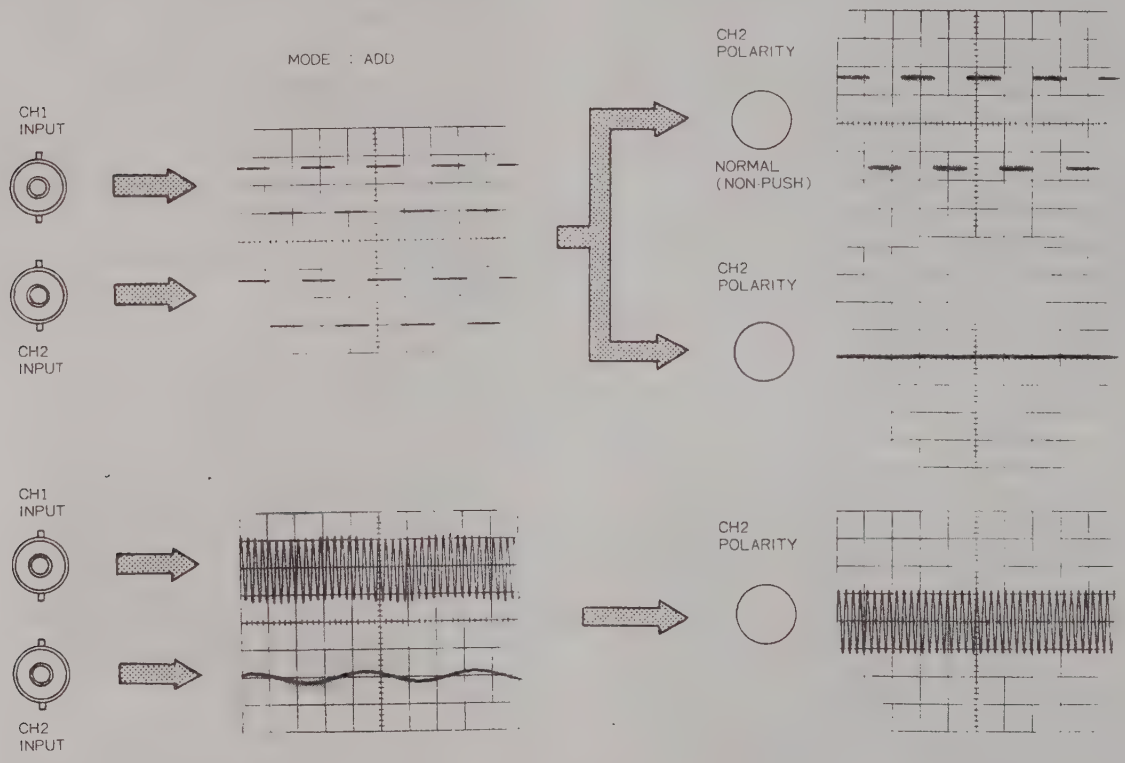
Observation in the ADD mode

The ADD mode is selected when both vertical MODE switches CH 1 and CH 2 are simultaneously pressed. When signals are applied to the INPUT connectors for channels 1 and 2 in this mode, the sum of the two signals (on channels 1 and 2) can be observed. When the CH 2 POSITION switch is pulled to the INV position, the difference between the two signals (channel 1 minus channel 2) can be observed.

In using the ADD mode, the deflection factors for the individual channels must be adjusted to suit the purpose.

The ↕ POSITION controls for both channels may be used for adjusting trace positions in the ADD mode. These switches, however, should be kept nearly at the center position for correct measurement.

Figure 2-4-2. ADD operation



2-4-3 Operation for Triple Trace Observation

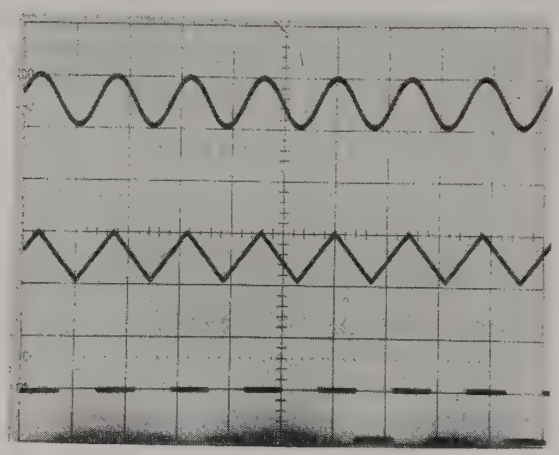
The SS-5705 can display not only two waveforms but three simultaneously on the CRT screen for observation.

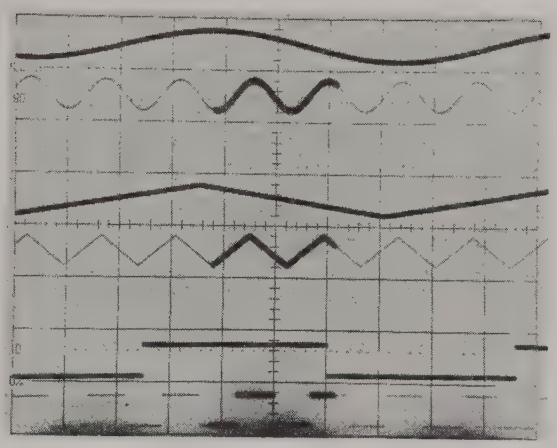
When the DUAL and X-Y switches of vertical MODE are pressed, three signals applied to the INPUT connectors for channels 1, 2, and 3 can be simultaneously observed.

If the ALT mode is selected in the above case by simultaneously pressing the A INTEN and B switches of HORIZ DISPLAY, three waveforms are displayed, and A INTEN and B sweeps for each channel are shown as in Figure 2-4-3, bringing the total of waveforms to six.

When the vertical mode CHOP is selected, triple waveforms are displayed chopped. If the ALT mode is selected, they are displayed alternately. Select the CHOP mode for observing signals that repeat slowly, or the ALT mode for observing signals that repeat fast.

Figure 2-4-3. Triple trace display





2-4-4 Operation as X-Y Scope

The SS-5705 operates as an X-Y scope if the vertical MODE X-Y is selected.

When signals are applied to the INPUT connectors for channels 1 and 2, the signal on channel 1 drives the horizontal axis (X) and the signal on channel 2 drives the vertical axis (Y) to display a Lissajou's figure.

By operating the SS-5705 as an X-Y scope, phase differences, Lissajou's figures of various frequency ratios, and hysteresis curves can be observed.

In using it as an X-Y scope, move the waveforms using the CH 2 vertical POSITION and horizontal POSITION controls.

The deflection factor for the X axis can be adjusted with CH 1 VOLTS/DIV and VARIABLE, and the deflection factor for the Y axis with CH 2 VOLTS/DIV and VARIABLE. When VARIABLE is turned to the CAL position, VOLTS/DIV indications directly represents the deflection factors selected.

Figures 2-4-4-(1) and -(2) show Lissajou's figures of sine waves of different frequencies. As shown, various figures are described depending on the phase difference and frequency ratio. All of them are to be observed still.

Figure 2-4-4-(3) shows examples of Lissajou's figures of

Figure 2-4-4-(1). Lissajou's figures of sine waves

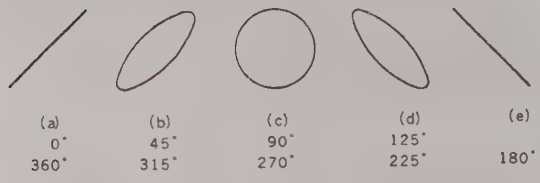


Figure 2-4-4-(2). Lissajou's figures of various frequency ratios

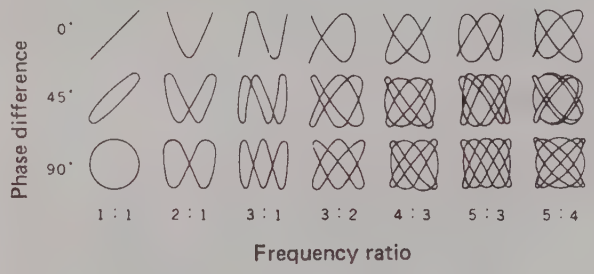


Figure 2-4-4-(3). Lissajou's figures of different waveforms (Frequency ratio: 1 to 1)

(a) Sine wave and triangle wave (b) Sine wave and square wave (c) Sine wave and sawtooth wave

2-4-5 Operation for Single Sweep Observation

Discharge waveforms and other high-speed transient phenomena, such as of relay chattering, are displayed in multiple overlapped waveforms in the normal high-speed repeating sweep mode. If the sweep rate is lowered to display an entire waveform, transient phenomena cannot be observed in detail. If the single sweep function is used, however, transient phenomena can be observed fully magnified in the horizontal axis direction, or recorded by photographing them. (See Figure 2-4-5.)

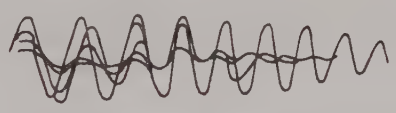
The basic single sweep operation procedure using a calibrated voltage as an input signal is described below.

1. Select the HORIZ DISPLAY mode A and horizontal MODE NORM.
2. Apply a calibrated voltage of 0.3 V to INPUT, using the supplied probe. Set VOLTS/DIV to 5 mV, and confirm proper triggering.
3. Select the horizontal MODE SINGLE, and press SINGLE/RESET so that a single sweep occurs.
4. Disconnect the input signal, and press SINGLE/RESET. Check the lower READY lamp that it lights.

If the READY lamp lights, the device is in a standby state for sweep. It performs a single sweep upon receiving a trigger signal. (The device may not be in a standby state at a point near the center of LEVEL. In that case, slightly turn LEVEL clockwise or counterclockwise.) When a signal is input to the device in this state, a single sweep takes place to properly display a waveform.

This single sweep operation is also possible in the A INTEN sweep and B (DLY'D) sweep modes. It is also possible in the external trigger mode if an external trigger signal is used in the same way as an input signal in the internal trigger mode. A simultaneous single sweep of two waveforms can be made only in the CHOP mode, not in the ALT mode.

Figure 2-4-5. Example of repetition sweep and single sweep waveforms



Repetition sweep

Single sweep

2-4-6 Operation for Television Signal Observation

The SS-5705 has a television trigger signal separation circuit which allows observation of waveforms of composite television signals. The operation procedure is as follows:

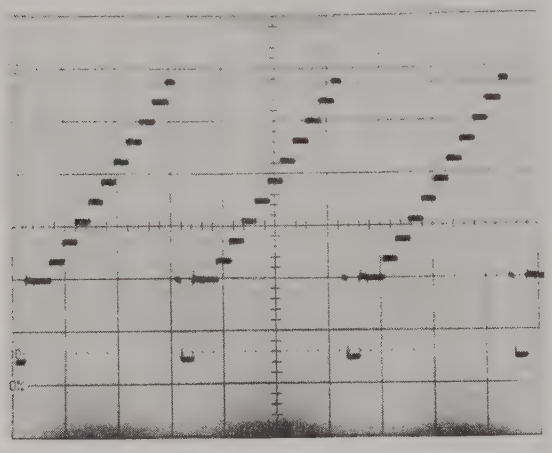
Observation by V trigger signal

1. Set the switches as follows:
   A TIME/DIV: 2 mSEC
   HORIZ DISPLAY: A
   Vertical MODE: CH 1 or CH2 (whichever a signal is applied to)
   COUPLING: TV
   SOURCE: CH 1 or CH 2 (whichever a signal is
   (Internal Trigger) applied to)
   (External Trigger) CH 3. Apply a signal to the INPUT connector for this channel.
2. Apply a composite television signal to channel 1/2 or channel 3.
3. Set VOLTS/DIV so that the trigger signal appears one division amplitude or more on the CRT screen.
4. Select the horizontal MODE of AUTO or NORM.
5. Turn SLOPE to the + position if the trigger signal is positive, or to the – position if it is negative.

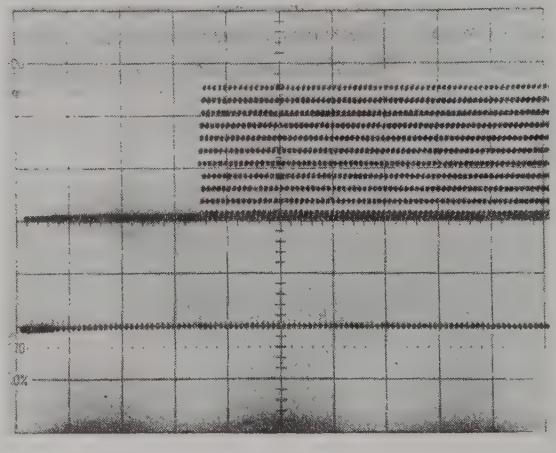
Observation by H trigger signal

1. In continuation of the above operations, select the HORIZ DISPLAY mode of A INTEN.
2. Set B TIME/DIV to 10 μSEC.
3. Set DELAY TIME to a point where the H trigger signal can be observed.
4. Select the HORIZ DISPLAY mode of B (DLY'D), and the desired magnification ratio with a TIME/DIV.
5. Press the TRIG'D – RUNS AFTER DELAY switch to the TRG'D position for stabilized triggering.

Figure 2-4-6. Television signal observation



(1) Example of observation of V trigger signal and video signal



(2) Example of observation of H trigger signal and video signal

2-4-7 Operation for Waveform Magnification

Part of the waveform displayed on the CRT screen can be magnified timewise (in the horizontal axis direction) for detailed observation in the following three ways.

- o Raising the sweep rate.
- o Magnifying by use of the MAG x1C function.
- o Magnifying by use of the delayed sweep function.

Each of these is described in detail below.

Raising the sweep rate

Select a high sweep rate for magnified observation of the tip of the waveform. Remember, however, that a high sweep rate moves the center and end of the waveform out of the CRT screen so they cannot be observed. In such a case, use the MAG function described below.

Waveform magnification by the MAG function

The MAG function is mainly used for magnifying the center or end part of the waveform displayed on the CRT screen.

As described in 2-3-11, move the desired part of the waveform to be magnified to the center of the screen with ↔ POSITION, and pull FINE (PULL x10 MAG) so that the desired part of the waveform is magnified ten times from the center of the CRT screen to the right and left. The trace length at this time is about ten divisions on the CRT screen, but is actually about 100 divisions. The trace can be observed full length by use of ↔ POSITION and FINE.

This method is simple, but the magnification ratio is limited to 1 to 10. The sweep rate for a magnified waveform is the value indicated by TIME/DIV multiplied by 1/10. The maximum sweep rate for magnified observation is 0.1 μs/division x 1/10 = 10 ns/division, as compared with the maximum sweep rate for non-magnified observation which is 0.1 μs/division.

Waveform magnification by the delayed sweep function

The above magnification method has the advantages of simple operation and raising the sweep rate by ten times the value indicated by TIME/DIV, but the magnification ratio is limited to 1 to 10.

The delayed sweep function permits magnification of any part of the waveform displayed on the CRT screen by a value dependent on the A-sweep to B-sweep ratio:

$$\frac{\text{A TIME/DIV (SEC/div)}}{\text{B TIME/DIV (SEC/div)}}.$$

This magnification method, however, is subject to limitation depending on the input signal frequency. In other words, if an input signal has a high frequency and if A TIME/DIV is at the highest rate position before magnifying the waveform, it cannot be magnified any more. Therefore, the delayed sweep magnification method is suitable to magnifying input signals of relatively low frequency for observing any desired parts of them.

This method comes in two types: RUNS AFTER DELAY and TRIG'D. (For detailed information, see 2-3-9.)

2-4-8 Operation for ALT sweep

The ALT sweep function is used for alternate A INTEN sweep and delayed B sweep. This allows simultaneous observation of the non-magnified part and magnified part of the waveform. The operation procedure is as follows:

1. Select the HORIZ DISPLAY mode A, input the signal to be measured, and triggered it.
2. Select a magnification ratio by the ratio of B TIME/DIV to A TIME/DIV. (See 2-4-7.)
3. Set the TRIG'D – RUNS AFTER DELAY button to the RUNS AFTER DELAY position.
4. Set the HORIZ DISPLAY mode ALT.
5. Move the B sweep to the desired part of the A sweep to be magnified, using DELAY TIME.

   Adjust the B sweep waveform (magnified waveform) to a position where it is easy to observe as shown in Figure 2-4-8-(1), using TRACE SEPARATION.

Note: When TRACE SEPARATION is fully turned counter-clockwise, the A sweep waveform and B sweep waveform (magnified waveform) completely register. When TRACE SEPARATION is fully turned clockwise, the B sweep waveform is about four divisions or more above the A sweep waveform.

Jitters occur as the magnification ratio is raised by changing the ratio of A TIME/DIV to B TIME/DIV. If jitters occur, push the TRIG'D – RUNS AFTER DELAY switch in to the TRIG'D position.

Figure 2-4-8-(1). Examples of A INTEN sweep and B sweep by TRACE SEPARATION

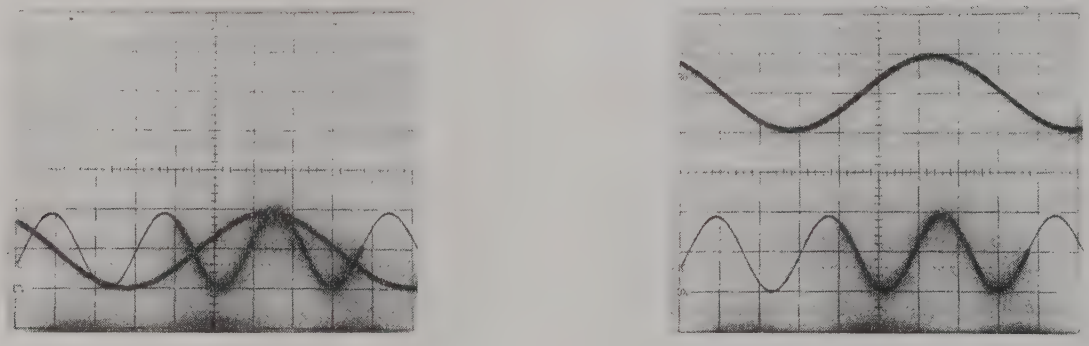
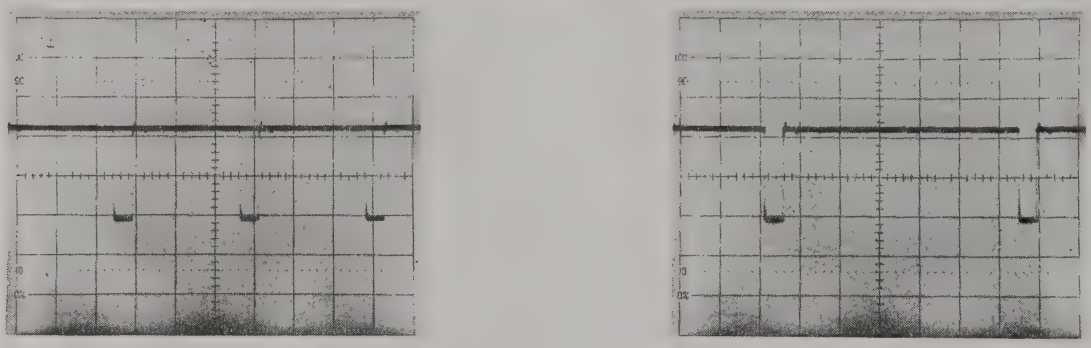


Figure 2-4-8-(2). Examples of the same waveformed displayed in RUNS AFTER DELAY and TRIG'D modes



Example of display in RUNS AFTER DELAY mode

Example of display in TRIG'D mode

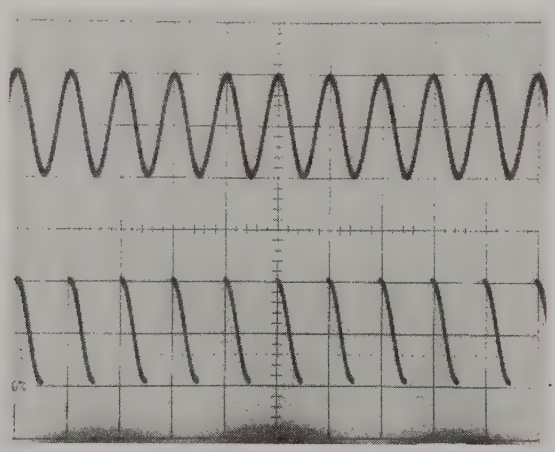
2-4-9 External Intensity Modulation

In addition to the vertical (Y) axis and horizontal (X) aixs, the Z axis is used for displaying signals to be measured. The SS-5705 is so designed that the intensity of the waveform displayed on the CRT screen can be changed by applying an input signal from Z AXIS INPUT on the rear panel to the CRT circuit. Intensity modulation of an intermediate level can be obtained by applying a signal not high enough to completely erase the displayed waveform.

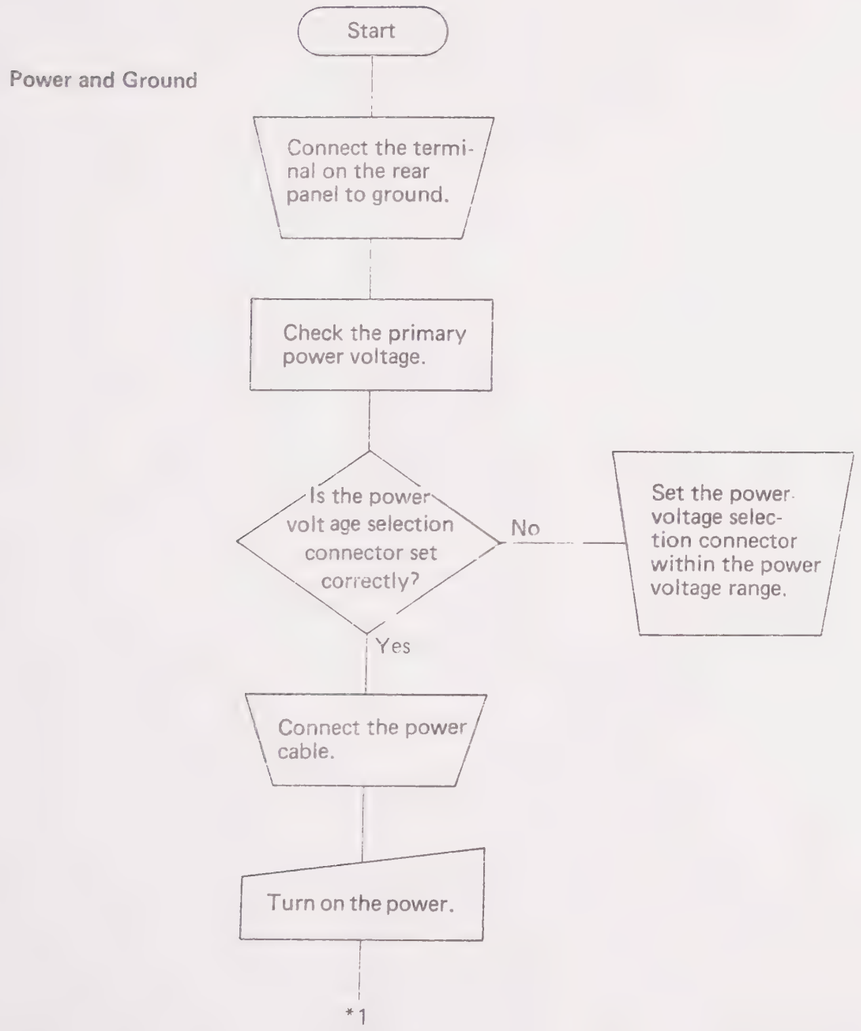
A negative signal increases the intensity, and a positive signal decreases it. An input voltage of 3 Vp-p produces a signal amplitude at which intensity modulation can be observed, provided that the intensity setting is correct. The effect input frequency range is from DC to 3 MHz, and the maximum input voltage is 50 V (DC + peak AC).

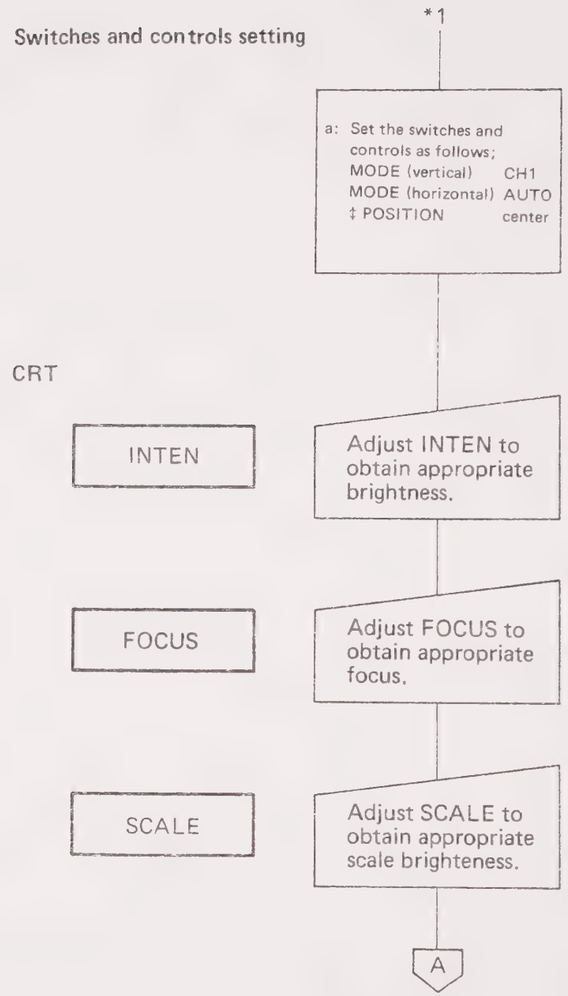
A time reference for displayed waveforms can be obtained by applying a time marker to Z AXIS INPUT. The time relationships of displayed waveforms observed at a non-calibrated sweep rate can be measured using this time marker.

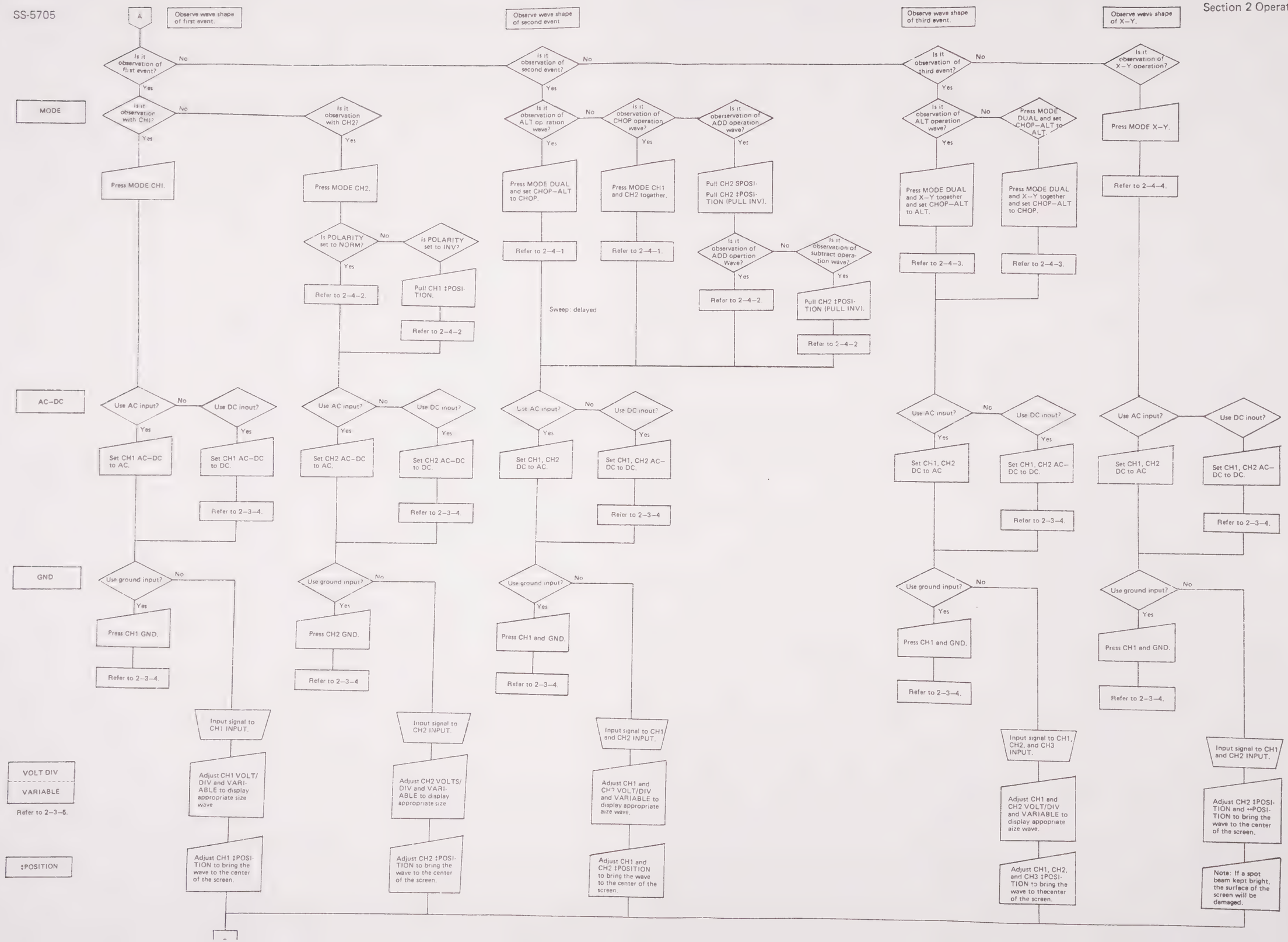
Figure 2-4-9. Example of intensity modulation display —



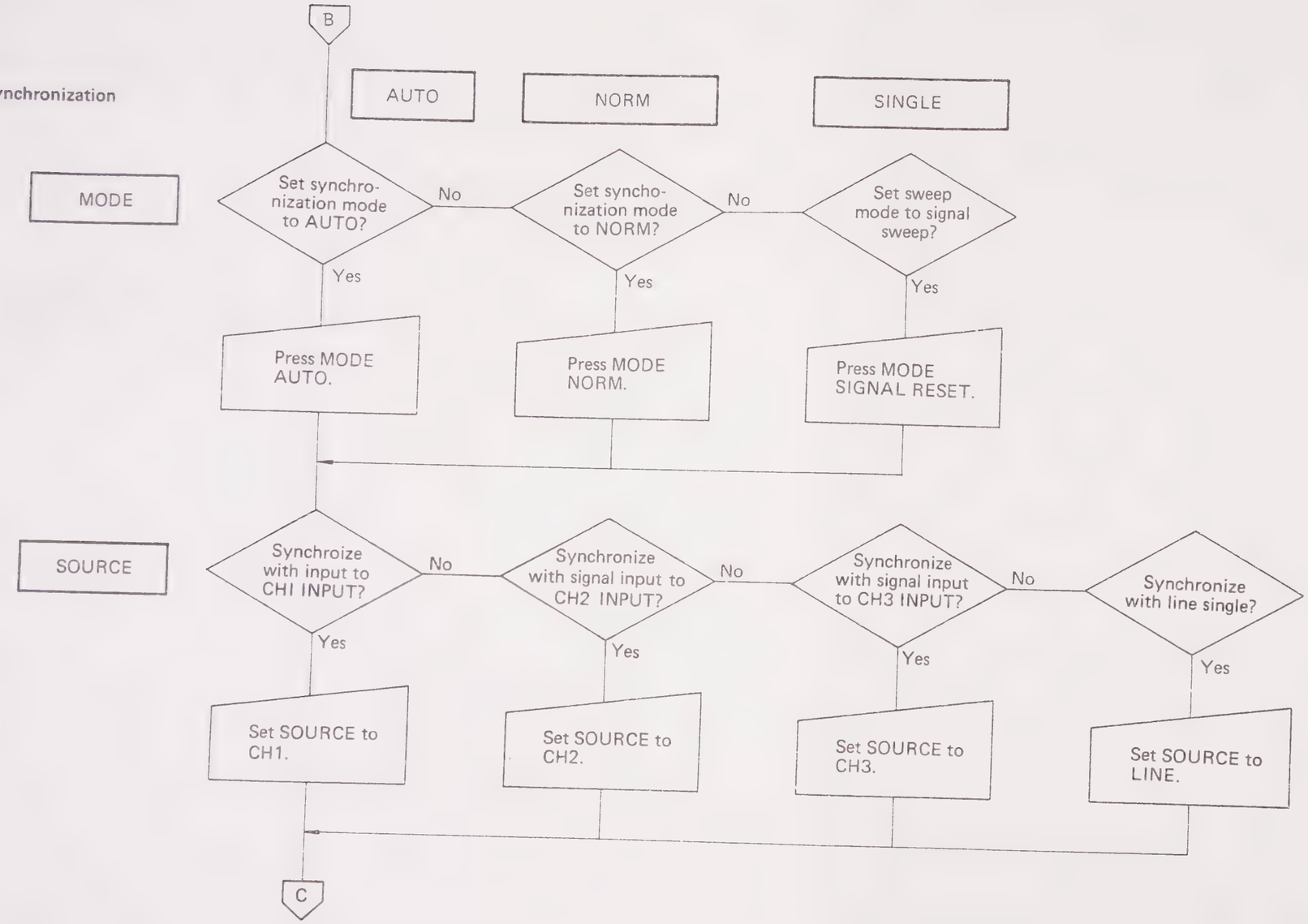
2-2 OPERATION FLOW

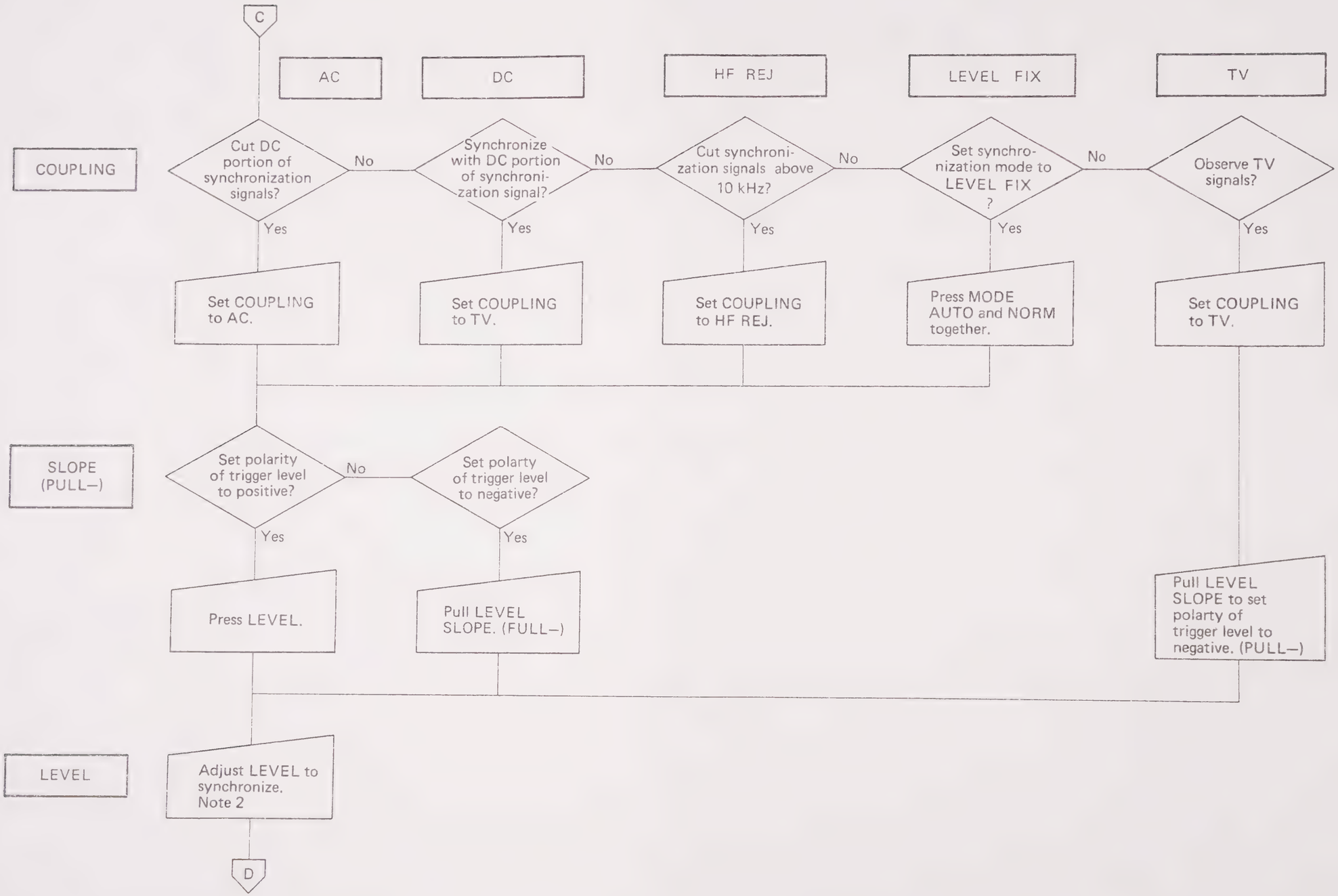

Start
Power and Ground
Connect the terminal on the rear panel to ground.
Check the primary power voltage.
Is the power volt age selection connector set correctly?
No
Set the power voltage selection connector within the power voltage range.
Yes
Connect the power cable.
Turn on the power.
*1

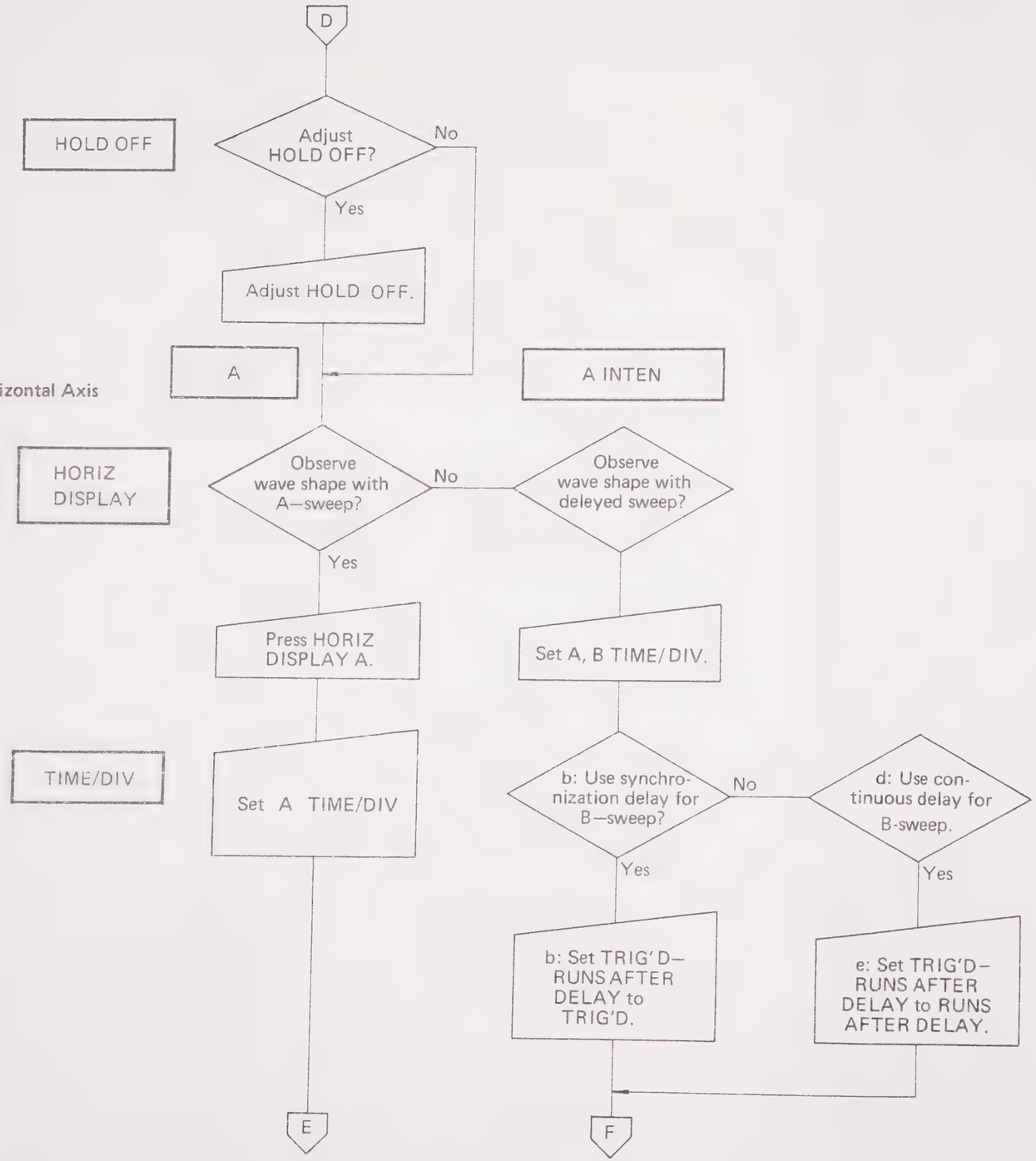


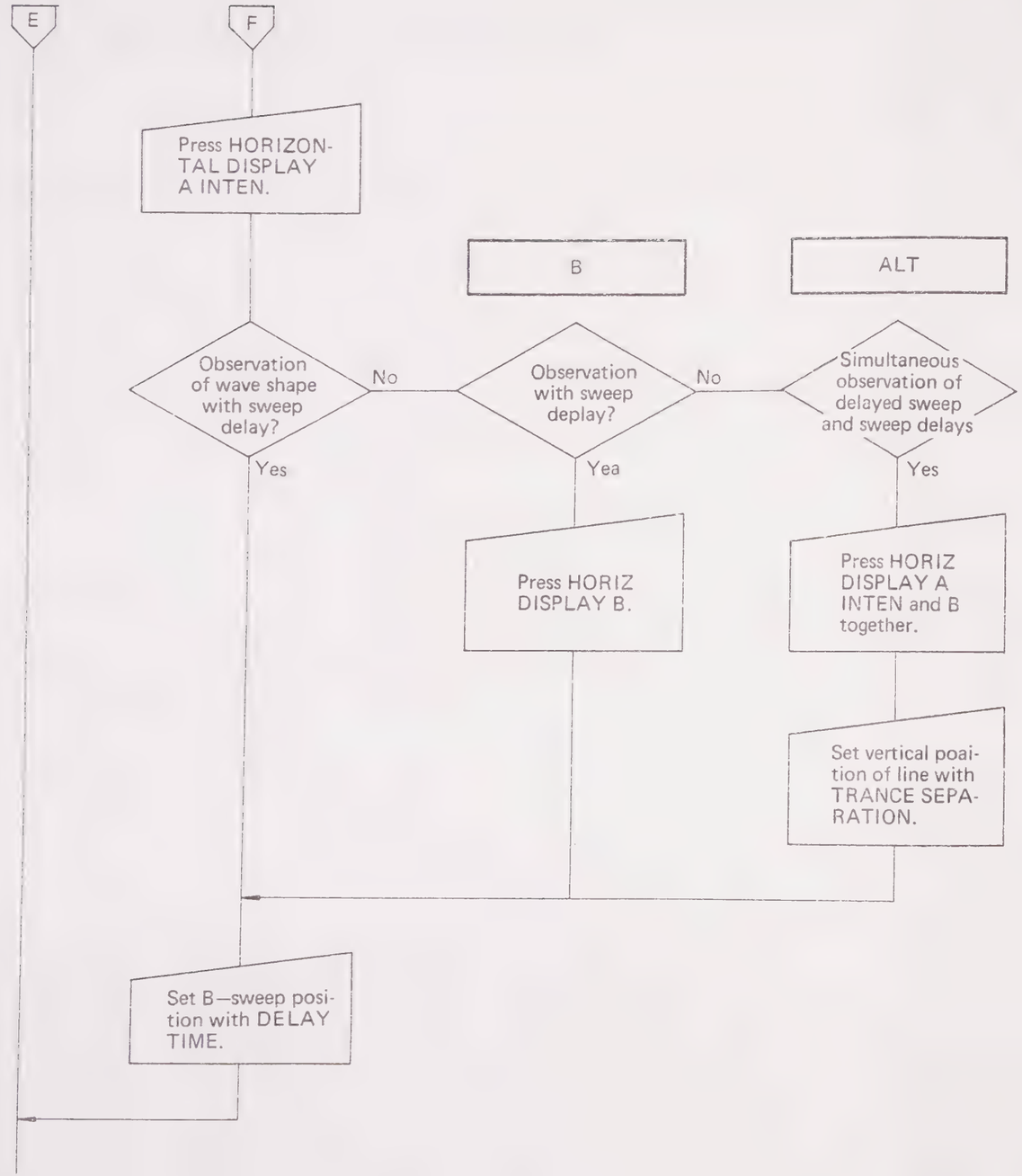

A
Observe wave shape of first event.
Is it observation of first event?
No
Yes
MODE
Is it observation with CH1?
No
Yes
Is it observation with CH2?
Yes
Press MODE CH1.
Press MODE CH2.
Is POLARITY set to NORM?
No
Is POLARITY set to INV?
Yes
Refer to 2–4–2.
Pull CH1 ‡POSITION.
Refer to 2–4–2
Observe wave shape of second event
Is it observation of second event?
No
Yes
Is it observation of ALT operation wave?
No
Yes
Is it observation of CHOP operation wave?
No
Yes
Is it observation of ADD operation wave?
Yes
Press MODE DUAL and set CHOP–ALT to CHOP.
Press MODE CH1 and CH2 together.
Pull CH2 SPOSITION
Pull CH2 ‡POSITION (PULL INV).
Refer to 2–4–1
Refer to 2–4–1.
Is it observation of ADD opertion Wave?
No
Is it observation of subtract operation wave?
Yes
Refer to 2–4–2.
Pull CH2 ‡POSITION (PULL INV).
Refer to 2–4–2
Sweep: delayed
Observe wave shape of third event.
Is it observation of third event?
No
Yes
Is it observation of ALT operation wave?
No
Yes
Press MODE DUAL and set CHOP–ALT to ALT.
Press MODE DUAL and X–Y together and set CHOP–ALT to ALT.
Press MODE DUAL and X–Y together and set CHOP–ALT to CHOP.
Refer to 2–4–3.
Refer to 2–4–3.
Observe wave shape of X–Y.
Is it observation of X–Y operation?
Press MODE X–Y.
Refer to 2–4–4.
AC–DC
Use AC input?
No
Yes
Use DC inout?
Yes
Set CH1 AC–DC to AC.
Set CH1 AC–DC to DC.
Refer to 2–3–4.
Use AC input?
No
Yes
Use DC inout?
Yes
Set CH2 AC–DC to AC.
Set CH2 AC–DC to DC.
Refer to 2–3–4.
Use AC input?
No
Yes
Use DC inout?
Yes
Set CH1, CH2 DC to AC.
Set CH1, CH2 AC–DC to DC.
Refer to 2–3–4
Use AC input?
No
Yes
Use DC inout?
Yes
Set CH1, CH2 DC to AC
Set CH1, CH2 AC–DC to DC.
Refer to 2–3–4.
Use AC input?
Yes
Use DC inout?
Yes
Set CH1, CH2 DC to AC
Set CH1, CH2 AC–DC to DC.
Refer to 2–3–4.
GND
Use ground input?
No
Yes
Press CH1 GND.
Refer to 2–3–4.
Use ground input?
No
Yes
Press CH2 GND.
Refer to 2–3–4
Use ground input?
No
Yes
Press CH1 and GND.
Refer to 2–3–4.
Use ground input?
No
Yes
Press CH1 and GND.
Refer to 2–3–4.
Use ground input?
No
Yes
Press CH1 and GND.
Refer to 2–3–4.
VOLT DIV
VARIABLE
Refer to 2–3–5.
Input signal to CH1 INPUT.
Adjust CH1 VOLT/DIV and VARIABLE to display appropriate size wave
Input signal to CH2 INPUT.
Adjust CH2 VOLTS/DIV and VARIABLE to display appropriate size
Input signal to CH1 and CH2 INPUT.
Adjust CH1 and CH2 VOLT/DIV and VARIABLE to display appropriate aize wave.
Input signal to CH1, CH2, and CH3 INPUT.
Adjust CH1 and CH2 VOLT/DIV and VARIABLE to display appopriate aize wave.
Input signal to CH1 and CH2 INPUT.
Adjust CH2 ‡POSITION and ↔POSITION to bring the wave to the center of the screen.
‡POSITION
Adjust CH1 ‡POSITION to bring the wave to the center of the screen.
Adjust CH2 ‡POSITION to bring the wave to the center of the screen.
Adjust CH1 and CH2 ‡POSITION to bring the wave to the center of the screen.
Adjust CH1, CH2, and CH3 ‡POSITION to bring the wave to thecenter of the screen.
Note: If a spot beam kept bright, the surface of the screen will be damaged.

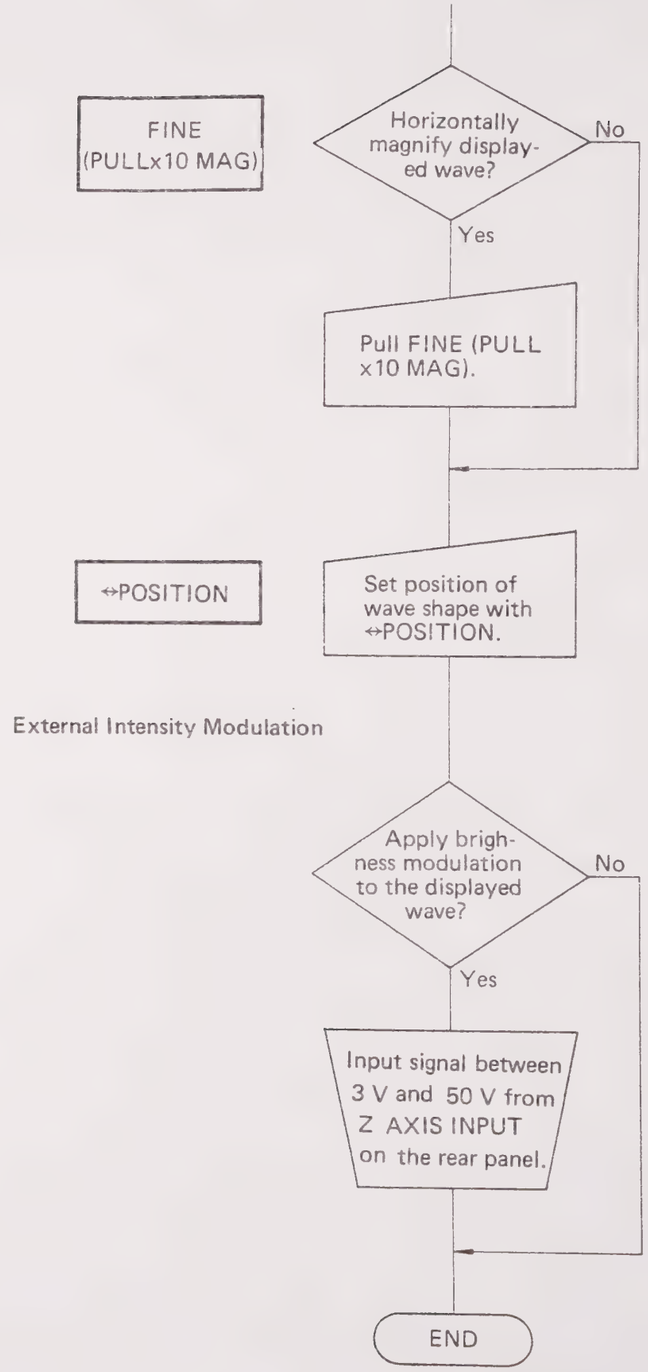
Synchronization




C
AC
DC
HF REJ
LEVEL FIX
TV
COUPLING
Cut DC portion of synchronization signals?
No
Synchronize with DC portion of synchronization signal?
No
Cut synchronization signals above 10 kHz?
No
Set synchronization mode to LEVEL FIX ?
No
Observe TV signals?
Yes
Yes
Yes
Yes
Yes
Set COUPLING to AC.
Set COUPLING to TV.
Set COUPLING to HF REJ.
Press MODE AUTO and NORM together.
Set COUPLING to TV.
SLOPE (PULL—)
Set polarity of trigger level to positive?
No
Set polarty of trigger level to negative?
Yes
Yes
Press LEVEL.
Pull LEVEL SLOPE. (FULL—)
Pull LEVEL SLOPE to set polarty of trigger level to negative. (PULL—)
LEVEL
Adjust LEVEL to synchronize. Note 2
D


D
HOLD OFF
Adjust HOLD OFF?
No
Yes
Adjust HOLD OFF.
A
A INTEN
Horizontal Axis
HORIZ DISPLAY
Observe wave shape with A—sweep?
No
Observe wave shape with deleyed sweep?
Yes
Press HORIZ DISPLAY A.
Set A, B TIME/DIV.
TIME/DIV
Set A TIME/DIV
b: Use synchro-nization delay for B—sweep?
No
d: Use con-tinuous delay for B-sweep.
Yes
Yes
b: Set TRIG'D—RUNS AFTER DELAY to TRIG'D.
e: Set TRIG'D—RUNS AFTER DELAY to RUNS AFTER DELAY.
E
F


E
F
Press HORIZONTAL DISPLAY A INTEN.
B
ALT
Observation of wave shape with sweep delay?
No
Observation with sweep deplay?
No
Simultaneous observation of delayed sweep and sweep delays
Yes
Yea
Yes
Press HORIZ DISPLAY B.
Press HORIZ DISPLAY A INTEN and B together.
Set vertical poaition of line with TRANCE SEPARATION.
Set B—sweep position with DELAY TIME.


FINE (PULLx10 MAG)
Horizontally magnify displayed wave?
No
Yes
Pull FINE (PULL x10 MAG).
↔POSITION
Set position of wave shape with ↔POSITION.
External Intensity Modulation
Apply brighness modulation to the displayed wave?
No
Yes
Input signal between 3 V and 50 V from Z AXIS INPUT on the rear panel.
END

Measuring Instructions

3-1 ADJUSTMENTS NECESSARY BEFORE MEASUREMENT

It may be necessary to adjust the adjusters on the front panel and bottom before attempting measurements in order to assure accuracy of measurements. In case of measuring with a probe, its phase adjustment is necessary. Whichever the case, the adjusting screwdriver (supplied as an accessory to the probes) may be used for adjustment purposes.

About 30 minutes of warmup is recommended for stabilizing operation before adjusting the controls and probe phase.

3-1-1 TRACE ROTATION Adjustment

Trace may become not parallel to the graticule lines on the CRT screen due to geomagnetic effect or other cause.

If that occurs, display a trace on the CRT screen, move it to the center of the screen with POSITION, and adjust the trace parallel to the graticule lines with TRACE ROTATION. Before making this adjustment, install the SS-5705 in the normal place of use for measurements.

3-1-2 Probe Phase Adjustment

10 : 1 Passive probe phase adjustment

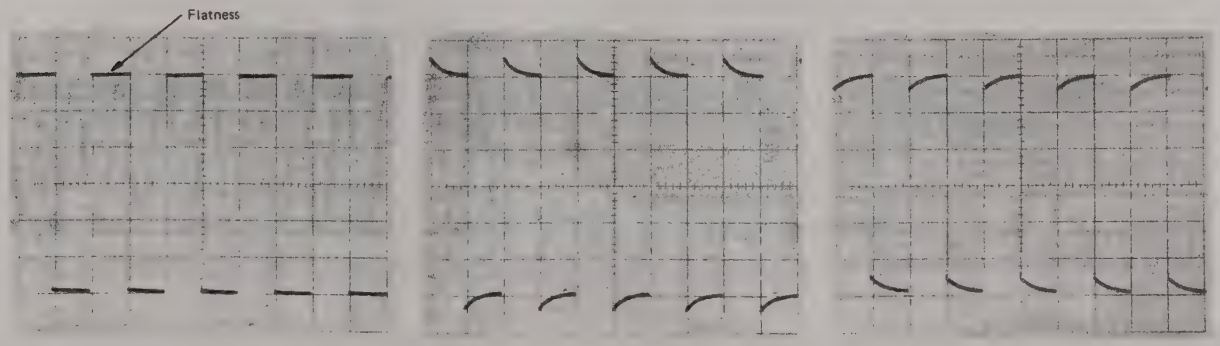
The following probes can be used for the SS-5705: Type SS-0011 (1.5 m long) with an attenuation ratio of 10 : 1; SS-0001 (1 m long), SS-0002 (1.5 m long), and SS-0003 (2 m long), the later three with an attenuation ratio of 1 : 1. (Those probes with an attenuation ratio of 1 : 1 are optional.)

A mismatched probe phase can result in measuring the wrong waveform. Be sure to correctly adjust the probe before use.

First, set VOLTS/DIV to 5 mV., connect the probe to INPUT and the CAL 0.3 V output terminal so that a calibration voltage waveform with an amplitude of 6 divisions is displayed on the CRT screen.

Next, turn the variable capacitor of the probe. The waveform changes as shown in figure 3-1 b or c. Adjust the variable capacitor correctly until the waveform is as shown in Figure 3-1 a.

Figure 3-1. Probe phase waveforms



a. Correct compensation

b. Excessive compensation

c. Insufficent compensation

3-2 MEASURING METHODES

3-2-1 Voltage Measurement

Quantitative Measurement

The quantitative measurement of voltage can be made by setting the VOLTS/DIV VARIABLE control to the CAL position. The measured value can be calculated by Equation (3-1)or (3-2).

a. Measurement with the x1 position of the probe;
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div)
. . . . . (3-1)

b. Measurement with the x10 position of the probe;
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div) x10 . . . . . (3-2)

DC Voltage Measurement

This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO. and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Figure. 3-2. Adjust the vertical POSITION control in order to place the trace exctly on a horizontal graticule, which facilitates the reading of signal voltage.
3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (3-1) or (3-2).

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows; Set the VOLTS/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Figure 3-3 and calculate by Equation (3-1) or (3-2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3-3.)

Figure 3-2. DC Voltage Measurement

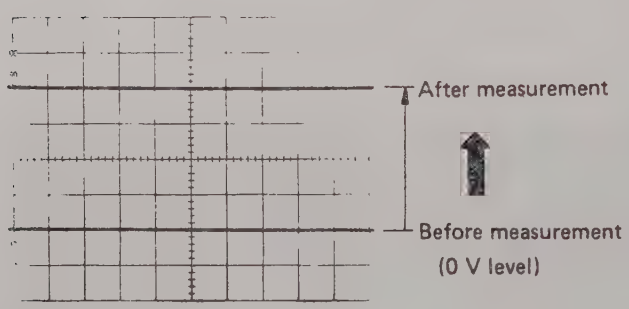
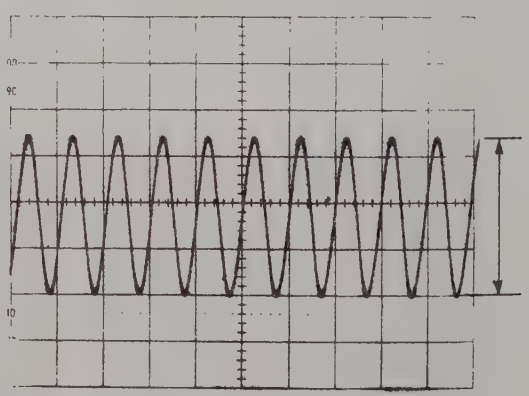


Figure 3-3. AC voltage measurement



$$\text{Effective voltage (V rms)} = \frac{\text{Peak voltage (V p-p)}}{2\sqrt{2}} \quad \ldots(3\text{-}3)$$

3-2-2 Time Measurement

The time interval of two points on a signal waveform can be calculated as follows: Set the TIME/DIV VARIABLE control to CAL. read the setting values of the TIME/DIV and x5 MAG switches and calculate the time by Equation (3-4).

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x5 MAG setting value. . . . . (3-4)

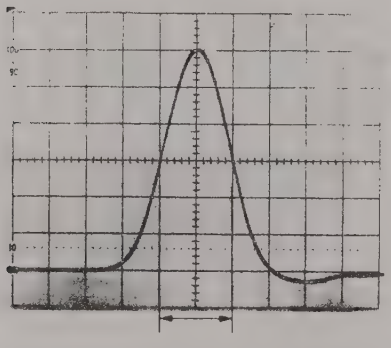
Where, the reciprocal number of the x5 MAG setting value is 1 when the sweep is not magnified, and 1/5 when the sweep is magnified.

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Figure 3-4.
2. Set TIME/DIV switch in order to make the easy observation of the signal.
3. Read the distance between centers of rising and falling edges, i.e., the distance between two points at which pulse edges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (3-4).

Figure 3-5. Pulsewidth measurement

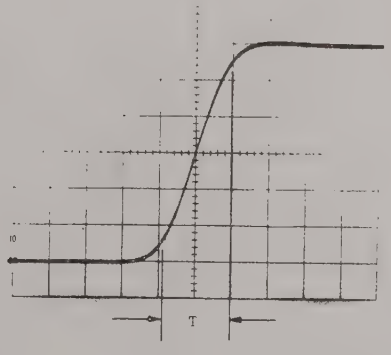


Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows.

1. Display the pulse waveform vertically and horizontally in the same manner as for the pulsewidth measurement procedure.
2. Turn the horizontal POSITION control in order to set the upper 10% point of the waveform on the vertical center line of the graticule. (In Figure 3-5, the upper 10% point is 0.4 division below the top of the pulse since the displayed amplitude is 4 divisions.) Read the distance T_1 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
3. Shift and set the lower 10% point of the waveform to the vertical center line of the graticule as shown by the dotted line in Figure 3-5. Read the distance T_2 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
4. Calculate the rise (or fall) time by substituting the sum of T_1 and T_2 for Equation (3-4).

Figure 3-6. Rise (or fall) time measurement



3-2-3 Frequency Measurement

Of the frequency measurement procedure, there are the following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (3-4) as shown in Figure 3-6, and obtain th frequency by Equation (3-5).

$$\text{Frequency (Hz)} = \frac{1\ (c)}{\text{Period (s)}} \quad \ldots\ldots\ldots\ldots\ldots (3\text{-}5)$$

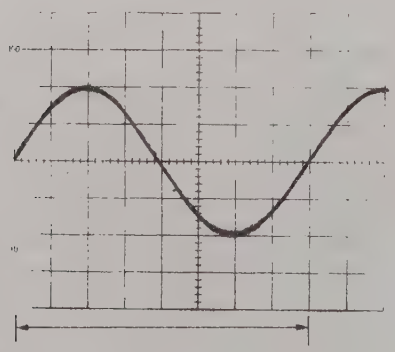
The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (3-6).

$$\text{Frequency (Hz)} = \frac{N\ (c)}{\text{TIME/DIV setting value (s/div)} \times 10\ \text{(div)}} \quad \ldots (3\text{-}6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the count below decimal point becomes very ambiguous, which results in considerable error.

For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the follwing method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pattern by applying the signal of which frequency is known, and read the necessay value.

Figure 3-7. Frequency measurement (1)



3-2-4 Phase Difference Measurement

Of the measurement of phase difference between two signals, there are the follwing two methods:

The first one is the Lissajou's pattern method by using the instrument as an X-Y scope. The phase difference of signals can be calculated form the amplitudes A and B of the pattern shown if Figure 3-8 and by Equation (3-7).

$$\text{Phase defference (deg)} = \sin^{-1}\frac{A}{B} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3\text{-}7)$$

The second method is an application of dual-trace function Figure 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the SOURCE switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the displayed sine wave may be 9 divisions.

Then, 1-division graticule represents a waveform phase of 40° (1 cycle $=2\pi=360°$). The phase difference between the two signals can be easily calculated by Equation (3-8).

$$\text{Phase difference (deg)} = T\ \text{(div)} \times 40° \quad \ldots\ldots\ldots\ldots (3\text{-}8)$$

Where, T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.

Figure 3-8. Frequency measurement (2)

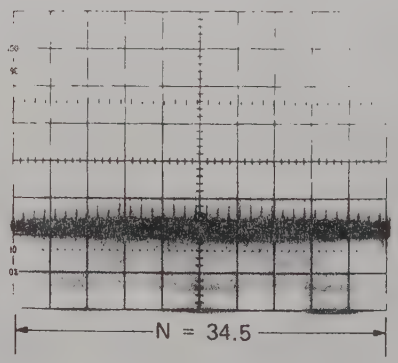


Figure 3-9 Phase difference measurement using Lissajou's pattern

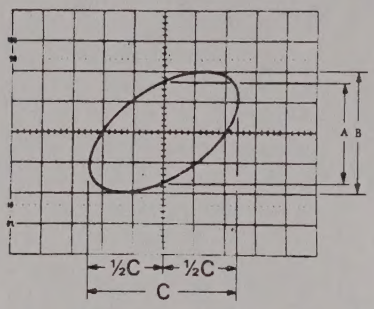
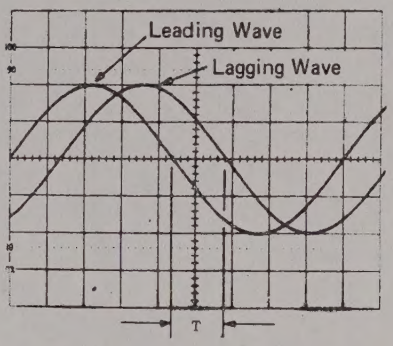


Figure 3-10. Phase difference measurement by dual-trace display



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